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# THE AMERICAN GAS LIGHT JOURNAL

REDMAN&KENNY,N.Y.

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

VOLUME LX.—No. 20. Whole No. 988. | NEW YORK, MONDAY, MAY 14 1894. | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager.
JOS. R. THOMAS, C.E., Editor. T. J. CUNNINGHAM, Asst. Editor.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND CLASS MATTER.

**Published** on each Monday of the year, at No. 32 Pine Street, N. Y.

**Terms of Subscription, Including Postage.**—For the United States and Canada, $3 per annum. European countries, $4.50 (19 shillings—22½ francs). All payments to be made in advance. Single copies, 10 cents.

**Remittances** should be made either by post-office order, express money order, registered letter, or bank draft on New York, payable to the order of A. M. Callender & Co.

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*The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.*

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[OFFICIAL NOTICE.]

### Seventeenth Annual Meeting, Western Gas Association.

SECRETARY'S OFFICE, WESTERN GAS ASSOCIATION,
QUINCY, ILLS., May 2, 1894.

The seventeenth annual meeting of the Western Gas Association will be held at Cleveland, O., on the 16th, 17th and 18th of May.

The Hollenden, strictly first class in all its appointments, will be the Association's headquarters, and its business sessions will also be conducted therein. The rates at the Hollenden will be as follows: On the American plan, $3, $3 50, $4 and $5 per day. On the European plan, $1, $1.50, $2, $3 and $3.50 per day.

It is intended that an exhibit of gas appliances shall form one of the prominent features of the Cleveland meeting, and to this end a commodious storeroom, directly across the street from the Hollenden, has been engaged. Manufacturers and dealers in stoves, ranges, burners, lamps, engines and all forms and types of apparatus or machinery by which the manifold uses of gas can be exhibited, are respectfully invited to display their wares; and they can feel assured that, on this occasion, the same will be critically inspected by large and appreciative audiences. Communications on the subject can be addressed to Mr. M. S. Greenough, General Manager of the Cleveland Gas Light and Coke Company, who will take pleasure in furnishing to exhibitors all requisite information in the matter.

So far the applications for space from exhibitors have far exceeded the anticipations of those in charge of the exhibition, and the members are assured that the display will be both comprehensive and interesting.

The following papers will be presented for the consideration of the members of the Western Gas Association on the occasion of its seventeenth annual meeting:

"Street Main Pressure," by Irvin Butterworth, Columbus, O.
"Some of the Advantages of Oil Gas Works for Small Towns," by J. W. Stratton, Valparaiso, Ind.
"The Best Method of Introducing Gas Stoves," by H. Wilkiemeyer, Evansville, Ind.
"Three Years in a Country Gas Works," by S. M. Highlands, Clinton, Ia.
"History of the Gas Meter," by Wm. McDonald, Albany, N. Y.
"How to Make Small Electric Light Plants Pay," by I. C. Copley, Aurora, Ills.
"Influence of Temperature on Purification," by Jas. Ferrier, Columbus, Ga.
"Report of the Committee on Electrolysis," by Geo. T. Thompson, Jas. Somerville and Alten S. Miller.

Geo. T. Thompson, of the Laclede Gas Light Company, St. Louis, Mo., has been appointed Superintendent of the Wrinkle Department for the coming meeting, and to him should be addressed all contributions to or communications bearing on subjects connected with said department, while all matter for the Question Box should be mailed to the Secretary. The contributions for the "Wrinkle" department already announced are:

"Some Retort House Devices" (four in number); and,
"Admission of Air for Reviving Iron Oxide," by Jas. W. Dunbar.
"Stack Valve for Chimneys," by Arthur Finnegan.
"Using a Dry Meter, Admitting Air for Revivification;" and,
"Basket for Melting Out Lead Joints," by Geo. T. Thompson.
"Signalling Excessive Vacuum at the Exhauster," by Jas. Ferrier.
"Safety Arrangement for Seals," by Irvin Butterworth.
"Bye Passing the Lower Tray of a Purifier," by E. H. Jenkins.
"Filter for Tar Well Overflow;" and,
"Using Bench Waste Gases Under a Boiler," by C. M. Keller.
"Analysis of Gas by Inspection," by O. O. Thwing.
"Portable Pipe Vise Bench," by B. E. Chollar.
"Taking Gas Temperatures at the Consumer's Meter," by H. W. Douglas.

The Committee of Arrangements—Messrs. M. S. Greenough (Chairman), D. R. Warmington, C. M. Higgins, Chas. R. Faben, Jr., Irvin Butterworth and Joseph Light—announce that a complimentary dinner will be tendered to the members of the Association, by the Gas Companies of Cleveland and some of the manufacturers of the same city, at the Hollenden, at 8 o'clock, P.M., Thursday, May 17th.

A meeting of the Board of Directors of the Association will be held at the Hollenden, at 10 o'clock, A M., Tuesday, May 15th, and it is earnestly hoped that every member of the Board will find it convenient to be present.

A hearty invitation is hereby extended to the members of kindred Associations to be present at the meeting and to participate in its proceedings; and this invitation is further extended to the fraternity generally.

Rates of one and one third fares for the round trip will be made, by the various Passenger Associations, to our members and their friends. This reduction is based on the certificate plan, as in former years. The territory in which the reduced transportation rates are available extends from the western border of the New England States to the Mississippi river, and from the Ohio river, north, to the great lakes, including the larger part of the Province of Ontario, but not Wisconsin. The Southern Passenger Association declined to make the reduction. The Secretary will be pleased to mail the necessary blanks to those who will avail themselves of this rebate, and he would also note that 100 fares are essential before the rebate takes effect.

The undersigned will be pleased to reply to all communications requesting detailed information concerning the meeting, not covered by this announcement and the notice which is to follow.

A. W. LITTLETON, Secretary.

[OFFICIAL NOTICE.]

**American Gas Light Association.**

OFFICE OF THE SECRETARY, PROVIDENCE, R. I., May 3, 1894.

To all Members of the Council: By direction of the President, I hereby give notice that there will be a meeting of the Council of this Association on May 15, 1894, at 8 P M., at the Hollenden, Cleveland, O.

As the business of the meeting includes much matter of importance besides the ordinary routine, every member is specially urged to attend.

Respectfully, A. B. SLATER, JR., Secretary.

## BRIEFLY TOLD.

THIS WEEK, AT CLEVELAND.—Nothing remains to be told, in connection with the meeting of the Western this week at Cleveland, that has not already been spoken about other than to say that all the preliminaries have been attended to with that care and precision which the executives and the committee of arrangements know so well how to observe. All that remains, then, is to hope for good weather, so that the meeting may be completely enjoyed, although it is needless to add that atmospheric conditions are powerless to dampen the ardor of those who will take part in the convention. The East will send at least a score of representatives, and, judging from the remarks that we have heard during the past fortnight from visitors to the office, from all parts of the country, we confidently predict that the Western's 17th Annual will be marked by the best attendance recorded in its history.

A BELATED INVITATION.—We regret to say that the following letter and invitation were received at a time too late for publication in our last issue, but are herewith given in the hope that this date is not too late to show the fraternal spirit that imbues them:

CLEVELAND GAS LIGHT AND COKE CO.,
CLEVELAND, OHIO, May 3, 1894.

To the Editor AMERICAN GAS LIGHT JOURNAL: Will you kindly publish the inclosed invitation. It has been sent to every member of the Western Gas Association, but some of them may have changed their addresses since last year. I would also say that in case we have visitors from other sections of the country, there will be no discrimination made against them in this regard, because they are not so fortunate as to belong to the Western Association.

Yours very truly,
M. S. GREENOUGH,
Vice-President Cleveland Gas Lt. Co.

The invitation referred to by Mr. Greenough is as follows:

"The pleasure of your company is requested at a dinner given in honor of the Western Gas Association, at the Hollenden, on Thursday, May the seventeenth, at half past six o'clock.

"THE CLEVELAND GAS LIGHT AND COKE CO.
"THE PEOPLES GAS LIGHT CO.
"THE LAKE SHORE FOUNDRY.
"THE SCHNEIDER & TRENKAMP CO.
"THE DANGLER STOVE & MFG. CO."

THE SITUATION IN BROOKLYN.—All the Brooklyn Companies are now virtually selling gas at $1 per 1,000 cubic feet, the Nassau Company having officially announced its determination to do so last week. We hoped that when the Nassau management came to meet the guerrilla-like tactics of its opponents, that the cut would be sharp and swift, for if blood is to be permitted, nay, assisted to flow, a deep puncture would be the best way of providing for it an opening. It is possible, though, that the Nassau half-way measure was merely made to show to its customers that they are in no danger of beholding another Company trying to undersell it, and we further believe that when Mr. Leggett's voice is heard in the Nassau's councils (he is now on his way home from Europe) there will be cheaper gas than Brooklyn has seen for many a day. The forcers of this squabble ought to be put on record for their acts, which threaten to injuriously affect the gas interests of the country; and the inciters of the whole affair are the proprietors of the Fulton-Municipal and the Williamsburgh Gas Light Companies. Nor need we say that it is not any desire to sell gas cheaply, as a permanent practice, which inspires them. Personal motives, and petty ones at that, are guiding them in what must seem to disinterested observers a suicidal conflict. By the way, the first outcome of their fatuous move developed last week, when the Lamps and Gas Committee of the Board of Aldermen offered a report recommending the rejection of the proposals submitted for the public lighting for the ensuing year. The Committee finds that the price of gas for ordinary consumption has been reduced 37.50 per cent. since 1885, whereas the reduction on gas supplied to public lamps in the same period has not exceeded 10 per cent. The Committee, by way of accenting the inequality of the situation, further remarks that since the bids for public lamp lighting were opened the Companies have voluntarily reduced their selling price to $1 per 1,000 cubic feet. This rejection will strike some of the belligerents pretty hard, for the Williamsburgh Company, notably, has enjoyed a pretty soft belonging in respect of its public lighting contract. Indeed, it would not surprise us if the Companies were obliged, as a direct result of their latest "voluntary reduction," to submit to a cut of from $3 to $5 per post per annum; and the general verdict throughout the country would be they were properly served.

[Prepared for the JOURNAL.]

## Oil Gas Tar.

By DURAND WOODMAN, Ph.D.

In a previous article (JOURNAL, Jan. 8, 1894) some experiments were described in regard to the separation of water from oil gas tar.

In the discussions on tar reported from meetings of the different Gas Light Associations, there seems to be a tendency to assume that the presence of water causes difficulties peculiar to oil gas tar, and also, that all oil gas tar is necessarily watery. Both these inferences are incorrect. In the first place, the admixture of water with any kind of tar, whether from shale oil, wood or coal, if present in any considerable quantity, causes foaming, bumping, violent ebullition, etc., if not carefully managed in the early stages of distillation. (See "King's Treatise," chapter on "Distillation of Coal Tar," Vol. II., pp. 278, 279.) And furthermore, any liquid of a high degree of viscosity will foam when boiled, owing to the inclosure and superheating of the particles of water. This phenomenon is encountered in all branches of technical and manufacturing chemistry.

In the second place, the tar selected for my experiments was purposely of the poorest quality, in order to give the extreme conditions to be met by any chemical method of dehydration. Not only is the average percentage of water in oil gas tar less than that contained in the sample experimented on, but some tars are almost free from water.

I have recently examined a lot containing only 1.1 per cent. of water, and this passed over in the distillation without any disturbance whatever. The yield of pitch a little over 50 per cent.; quality good, and with indications of being especially adaptable to the preparation of a paint or varnish.

The tar itself seems to dry quickly, when spread as a varnish on glass, and any absorbent surface would hasten the drying by taking up the oily portion.

The rapidity with which this tar may be distilled makes it desirable in those cases where pitch only is the portion desired.

## Cox's Gas Flow Computer.

In every calculation concerning the discharge of gas from pipes, five factors have to be taken into consideration—namely:

1. The specific gravity of the gas (air = 1.0).
2. The initial pressure in inches of water.
3. The diameter of the pipe in inches.

4. The length of the pipe in feet.
5. The discharge in cubic feet per hour.

The formula generally used is the one known as Professor Pole's, as follows:

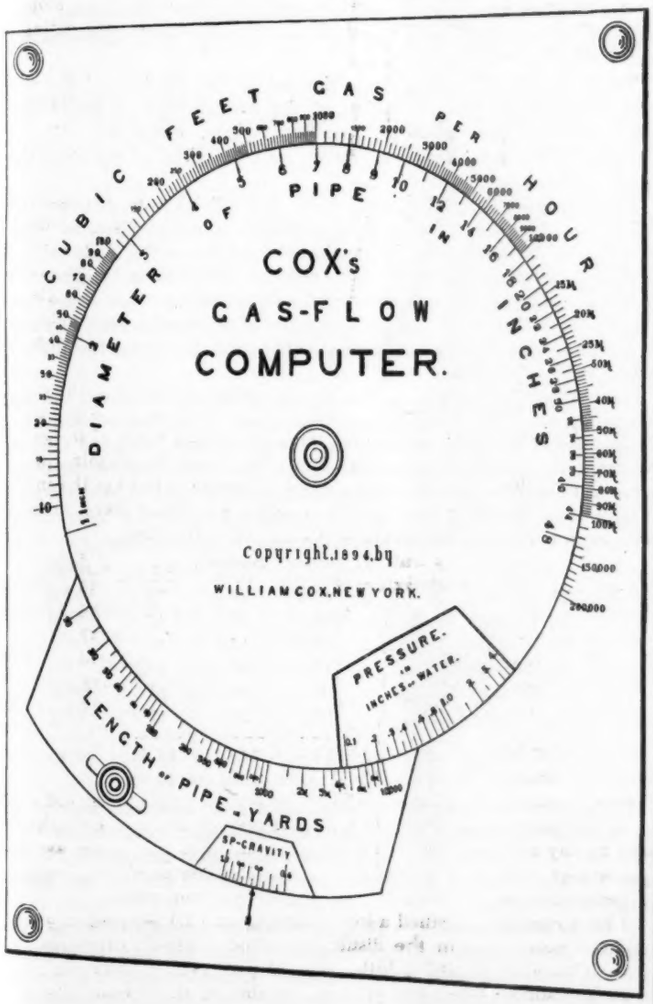
$$\text{Discharge in cubic feet per hour} = 1350\sqrt[5]{\frac{\text{Diameter}^5 \times \text{Pressure}}{\text{Sp. Gravity} \times \text{Length}}};$$

from which we also have—

$$\text{Diameter of pipe in inches} = \sqrt[5]{\frac{\text{Discharge}^2 \times \text{Sp. Grav.} \times \text{Length}}{1350 \times 1350 \times \text{Pressure}}};$$

$$\text{Pressure in inches water} = \frac{\text{Discharge}^2 \times \text{Sp. Grav.} \times \text{Length}}{1350 \times 1350 \times \text{diameter}^5}.$$

It will be at once seen that not only is the working out of the these formulæ long and tedious, but also that they do not allow of variations of the result being at once seen when any one factor is modified; on the contrary, each solution is confined to the values given to each one of the factors. To make this clearer, let us suppose that we wish to ascertain what diameter of pipe, 1,000 feet long, will be required to discharge 35,000 cubic feet of gas in one hour, its specific gravity being




0.4, and the pressure 0.5 inches of water. From the second formula we find the diameter necessary would be 14 inches. But suppose that certain existing conditions render the use of a pipe of this size undesirable or impossible, what modifications can be made in the other factors whereby we may use a smaller pipe and still obtain the same discharge?

The fixed or invariable quantities in our problem are the discharge and the length of the pipe, the variable quantities being the diameter, the pressure and the specific gravity. What is wanted is some means by which we can at once see all the different possible combinations of these three variable quantities or factors, and still obtain the same discharge.

The accompanying figure represents a novel device, called a Gas Flow Computer by the inventor, Mr. William Cox, of Stapleton, N. Y., which effects this in the simplest manner possible, without any computation and almost instantly.

Cox's Gas Flow Computer consists of a foundation plate with a clearly printed graduated outer circle or *dial*, within which a *disc*, similarly graduated on its outer edge, revolves around their common center. These graduations are scales representing a wide range of values of certain of the factors of the formula, and are so arranged that by turning the disc round, any division of a scale on the disc may be brought into contact with, or *set opposite* any division of the scale on the dial. There is also at the bottom of the instrument a small *arc*, capable of a slight circular motion about the common center, having also two scales, the graduations of the lower one being always in contact with an arrow on the foundation plate, while the graduations of the upper one work into one of the scales on the disc. These different scales correspond to the five factors of the formula referred to, and by turning the disc round and combining certain divisions or quantities of any four scales, the resulting value of the fifth is immediately seen. The whole is mounted on a substantial board 12 × 15 inches, and is provided with brass swivels and nuts for locking the disc and arc in any desired position, as shown in the figure.

The method of using the computer is as follows:

1. Unlock both nuts.
2. Turn the arc round until the graduation representing the specific gravity of the gas is "opposite" the arrow, then lock the arc.
3. Turn the disc round until the pressure in inches of water is opposite the length of pipe in the arc.
4. Now, opposite any diameter of pipe on the disc, will be at once seen on the dial the discharge in cubic feet per hour: or, opposite any given required discharge on the dial, find the necessary diameter of pipe on the disc.

We have thus with one "setting" of the disc two factors (the diameter and the discharge), either of which may be varied at pleasure, but which always correspond to one another. By now bringing any other pressure opposite the given length of pipe, we can, in two or three minutes, examine and note the results of an endless number of combinations, from which selection of the most suitable one may be made. Thus, in five minutes can be solved what would take hours of tedious calculation, and that with far greater appreciation of the effects produced by a slight modification of any one of the factors than can be obtained by working out any number of suppositional cases by means of the formulæ. Of course, in any of these problems the specific gravity may also be considered as a variable factor, and the modifications which any alteration in the specific gravity of the gas may produce in the other factors or in the result, may also be at once seen.

Briefly, therefore, what Cox's Gas Flow Computer does:

1. It gives at a glance the discharge of gas from pipes 1 to 48 inches diameter and 10 to 10,000 yards long, for any pressure from 0.1 to 4.0 inches of water, and any specific gravity from 0.40 to 1.00.
2. When the required discharge and the length of pipe are given, the diameter corresponding to any pressure is at once seen.
3. When the required discharge and the length of pipe are given, the pressure corresponding to any diameter is at once found.
4. Any suitable combination of the different factors of any problem, under all possible conditions, may be immediately found.

## London Coal Gas and Its Enrichment.

[A paper read by Prof. V. B. Lewes before the Society of Arts.]

Concluded from page 661.

There are two causes for the alteration which has taken place in the composition of coal gas, one of which is that in the metropolitan gas works it is now customary to use higher retort temperatures than were formerly employed, and this has tended to increase the percentage of hydrogen in the gas not only supplied by the Gas Light and Coke Company, but also by the South Metropolitan and the Commercial Companies, as shown in the following table:

| Constituents. | South Metropolitan. | Gas Light and Coke Company. | Commercial. |
|---|---|---|---|
| Hydrogen | 52.22 | 53.36 | 52.96 |
| Unsaturated hydrocarbons | 3.47 | 3.58 | 3.24 |
| Saturated hydrocarbons | 34.76 | 32.69 | 34.20 |
| Carbon monoxide | 4.23 | 7.05 | 4.75 |
| Carbon dioxide | 0.60 | 0.61 | 0.75 |
| Nitrogen | 4.23 | 2.50 | 4.10 |
| Oxygen | 0.49 | 0.21 | 0.00 |
| | 100.00 | 100.00 | 100.00 |

The second cause at present affects the gas supplied by the Gas Light

and Coke Company alone, and is to be found in one of the methods of enrichment which they adopt.

In large towns like London, where the gas companies have to supply a gas of specific illuminating power, and the gas is continually subjected to photometric tests at stations spread over the whole area supplied—any deficiency in the lighting value of the gas being visited with rigorously enforced penalties—enrichment, in some form or other, becomes a practical necessity. In London, the gas has to have an illuminating power of 16 candles; and in order to insure this over the enormous area supplied, the gas must be sent from the works testing up to 17 to 17 5 candles. With seaborne Durham coals, of the character most largely used in the metropolis for gas making, the illuminating value of the gas will be about 15 candles, and the gas manager has to enrich the gas by from 2 to 2½ candles before he can with safety send it out for distribution. This enrichment is done in several ways: (*a*) by the admixture of a certain percentage of cannel coal with the original gas coal, (*b*) by carbureting the coal gas with the vapors of volatile hydrocarbons, (*c*) by mixing the gas with carbureted water gas.

Up to four years ago, the admixture of a certain percentage of cannel coal with the Durham coal was the only method of enrichment employed by the metropolitan companies, and about that time the increase in price of cannel forced the companies to find some other process which should take its place, and the Gas Light and Coke Company tried experiments which led to their largely adopting carbureted water gas for this purpose.

When steam acts upon carbon at a high temperature, the resulting action may be looked upon as giving a mixture of equal volumes of hydrogen and carbon monoxide, both of which are inflammable but non-luminous gases. The water gas is then carbureted—*i. e.*, rendered luminous by passing it through heated chambers in which oils are decomposed by heat, and the mixture of oil gas diluted with water gas is made of such "richness" as to give an illuminating value of 24 or 25 candles, and this mixed with the poor coal gas brings up its illuminating value to the required limit, and during the winter months the gas supplied in the city has mostly contained about 10 per cent. of the carbureted water gas.

Carbureted water gas burns with a short but very brilliant flame, far shorter than coal gas, a 22 candle water gas flame burning from a London Argand at the rate of 5 cubic feet an hour with a flame only 2½ inches in height, whilst a 16 candle flame of the gas supplied up to three years ago gave a flame 3 inches in height; and by an extended series of experiments I have been able to show that the coal gas now supplied and enriched with the carbureted water gas only gives a flame 2.6 inches in height, in order to emit a light of 16 candles, instead of 3 inches, as formerly was the case.

Under the Gas Companies' Acts, they are bound to supply a gas which, at the official testing stations, shall emit a light equal to 16 sperm candles, consuming 120 grains of sperm per hour, and as no Parliamentary restriction is placed upon the composition of the gas, the companies are perfectly within their rights in supplying gas of the kind now sent into the city, and the only remedy is to make it known to the gas consumers that if they desire their gas bills to remain at the same figure as before carbureted water gas was used as an enricher, they must study the light emitted by the flame, and not its size.

The gas sent out by the Commercial and South Metropolitan, and also some portion of the Gas Light and Coke Company's gas, is not enriched by carbureted water gas, but by charging it with the vapors of highly volatile hydrocarbons until the desired illuminating value is reached, and gas so enriched gives a flame of the same size as formerly, so that in the districts supplied with it, the increase in consumption has not been noticed. Statements have been made in the public press, and I have also heard the opinion expressed by private individuals, that the gas companies send out gas which is far below the standard illuminating value. In order to do this, the companies would have either to have one set of mains to conduct gas to the consumer, and another set to supply the official testing stations, or else to specially carburet the gas close to the testing stations; a third supposition being that some of the trunk mains can have no official testing station attached to them near the points at which the distribution of the gas to the consumers commences. The first two theories would mean gross fraud on the part of the companies, which it would be absurd to seriously consider, and moreover would not be practicable, whilst the third supposes carelessness on the part of the authorities empowered to look after the gas supply of the metropolis, and I can assert from personal observation that none of these causes exist in the area of the city.

The gas companies are compelled by Act of Parliament to supply gas of a certain quality, and the gas referees, who have to decide upon the meaning of the acts and the way in which they are to be carried out, evidently translate this as meaning that the gas is to be supplied to the area in which it is to be consumed, of the specified illuminating value.

Interpreting the act in this light, the official testing stations are fixed in the city at the points where the great trunk mains deliver the gas to the districts to be supplied, and it is only under exceptional circumstances that the illuminating value of the gas is ever found to be below the required limit at these points.

In the big mains the gas is continually flowing at a fairly steady rate, and is neither exposed to any great alteration in temperature, nor from the size of the mains, to any very great amount of "skin friction"—*i.e.*, rubbing of the gases against the sides of the pipes; but as soon as distribution commences, both these factors come into play, and as some of the chief illuminants of the gas are vapors and not permanent gases, lowering of temperature causes condensation of some of them, whilst the power which friction against the sides of the main service pipes, coated with deposited hydrocarbons, has of withdrawing the illuminants from the gas, still further decreases its light giving value, whilst anywhere near the dead end of a service, stagnation in the gas during a large proportion of the 24 hours, when gas is not being consumed, adds still further to the trouble, and even at the testing stations, the influence of the small consumption of the gas on Sundays, and consequent stoppage in the manufacture on that day, can be traced in the illuminating value found on Monday morning.

The three official testing stations situated on the confines of the city area, at Kinghorn street, Clothfair, at the Aldgate end of Fenchurch street, and in Dorset buildings, Salisbury square, whilst my office in Guildhall Chambers, Basinghall street, may be taken to represent the heart of the city.

The tests taken daily at my office are not official tests, because the office has not been certified by the gas referees, and, therefore, no legal action could be taken upon the results obtained, but as the *modus operandi* and the apparatus are the same as in an official testing station, the results are of equal value as showing the illuminating value of the gas, and the following results (in the next table) of an average week's testing will give an idea of the effect which distribution has upon the illuminating value of the gas.

If the construction placed on the wording of the act is correct, the gas companies more than fulfil their parliamentary obligations as judged by the average of the year's supply, but if the illuminating value of the gas delivered to each individual consumer is to be a minimum illuminating value of 16 candles, then the testing stations would have to be at the end of the service instead of the intake, and check tests would have to be taken with portable photometers on the consumers' premises.

| Date. 1893. | Guildhall Chambers. | Fenchurch Street. | Clothfair. | Dorset Buildings. |
|---|---|---|---|---|
| Nov. 20, Monday..... | 15.4 | 16.0 | 16.2 | 16.4 |
| " 21, Tuesday..... | 15.3 | 16.3 | 17.0 | 16.6 |
| " 22, Wednesday..... | 15.5 | 16.5 | 16.7 | 17.3 |
| " 23, Thursday..... | 15.6 | 16.5 | 16.7 | 16.4 |
| " 24, Friday ..... | 16.0 | 16.8 | 16.6 | 16.8 |
| " 25, Saturday..... | 16.2 | 16.9 | 17.2 | 17.1 |
| Mean..... | 15.66 | 16.50 | 16.66 | 16.76 |

Mean of the three official testing stations, 16.64.

Whilst, however, the public strains at a gnat, and feels injured if the illuminating value of the gas falls to the slightest extent below the standard, they swallow the camel with the greatest suavity, and consume the gas supplied to them by methods of the crudest and most wasteful description.

Of all the many questions which at the present time affect the coal gas industry, there is probably none of more importance than the method by which gas is consumed. The companies in London are tied down by the Legislature to supply gas of an illuminating power of 16 candles; and when we come to consider what this in reality means, we find that, by one of those subtle strokes of humor in which our Legislative body occasionally indulges, it means to the consumer almost anything except a light equal to 16 candles. The amount of illumination which can be obtained by the consumption of coal gas is entirely dependent upon the method by which the gas is burned. From a so called 16-candle coal gas the consumer rarely obtains a value of more than 12 candles per 5 cubic feet of gas consumed; while by using burners of rational construction, upwards of 40 candle illuminating power could be obtained for the same consumption of gas.

The light emitted by a coal gas flame is entirely dependent upon its temperature, and flat flame burners, exposing a thin sheet of flame to the cooling action of the air, give the worst results. Argand burners are better, as the cooling is not so great, whilst the regenerative burners

lately introduced, by utilizing the heat of the products of combustion for raising the temperature of the gas and air supplied to the flame, give an enormous increase in the light emitted.

If the gas companies could only get an act passed authorizing the use of a regenerative burner as the standard, there is no reason why they should not call the gas at present supplied 40 candle gas, the consumer, however, using the flat flame burner, would still be only obtaining the light he did in 1850. Incandescent mantle burners, which act on a totally different principle, also yield a high illuminating value.

On carefully testing the burners in ordinary use we find that, for an equal consumption of gas, the results at once show the enormous advantage to be obtained by regeneration, and also how serious is the loss which attends the employment of ordinary burners:

*Light Obtained per Cubic Foot of 16 Candle Gas Consumed.*

| Burner. | Candle Units. |
|---|---|
| Regenerative and incandescent | 7 to 10.00 |
| Standard Argand | 3.20 |
| Ordinary " | 2.90 |
| Flat flame No. 7 | 2 44 |
| " No. 6 | 2.15 |
| " No. 5 | 1.87 |
| " No. 4 | 1.74 |
| " No. 3 | 1.63 |
| " No. 2 | 1.22 |
| " No. 1 | 0.85 |
| " No. 0 | 0.59 |

These burners were by well known makers; but there are plenty of cheap German nipples in the market which will give even worse results. In the above table, No. 7 is the largest flat flame burner given, as any larger size would never be used for indoor illumination, but with some of the big flat flame burners employed for outdoor work, as much as 3 candle power per cubic foot of gas is developed by the best make, while it is also quite possible to find cheap imitations of them, which can scarcely be distinguished by their appearance, only developing a little more than 1 candle per cubic foot. It seems probable that 10 candle units represents the maximum light to be obtained in practice per cubic foot from the so-called 16 candle coal gas, as, although greater regeneration will increase it as high as 16 units, the heat is so intense that the burner is quickly destroyed. Taking 10 candle units as being the maximum amount of light for a consumption of 1 cubic foot of gas per hour, we can now form an approximate idea of the waste of illumination which attends the ordinary methods of burning the gas.

If the burners most commonly in use in houses be examined, they will be found to consist chiefly of No. 4 and No. 5 flat flame nipples; and I do not think I should be overestimating the number in use if I put them at 85 per cent. of the total. The remaining 15 per cent. is made up of larger flat flame burners, Argands, and regenerative lamps, which give a higher service; but it will be found that the total value obtained will not exceed 2.5 candles per cubic foot. This means that 75 per cent. of the total value obtainable from the gas is wasted, and that for our present expenditure in coal gas we could obtain four times as much light.

In the middle of January this year the *Daily News* published an article on the quality and testing of London coal gas, in which a proposition was first made public, that unenriched coal gas should be supplied to the consumer at a lower rate than is at present charged for the enriched 16 candle gas, and this question is of such interest and importance to both consumer and gas company that any paper dealing with the present status of our gas supply would be incomplete without taking this question into consideration.

As before stated, the coal gas as made from Durham coal at the temperatures employed in the metropolitan gas works has an illuminating value of from 14 to 15 candles, and the enrichment of this gas up to the required value costs far more pro rata than the amount of light obtained from the unenriched gas.

This cost has entirely to be borne by the consumers, and the whole practical question to be decided resolves itself into this: "Is the game worth the extra candle and a half?"

If coal gas were used for illuminating purposes only, I believe the consumer would be a considerable gainer by having the unenriched gas supplied at a lower price, and when we consider the amount of gas used as a fuel, and that the quantity thus employed is daily increasing, the cost of enriched gas becomes of the greatest importance. One of our greatest authorities on coal gas has computed the value of one candle in illuminating power in the gas supplied to London at £200,000, and if his calculation be correct the consumers in the metropolis would be saved about £300,000 a year by using unenriched coal gas; and I venture to say that not one of them would notice the slightest difference in the light emitted by the gas in the burners ordinarily in use, whilst with regenerative burners the difference would be still less.

My reasons for this statement are as follows: I have already shown that the flat flame burners, although convenient and easily fitted, only develop a very small proportion of the light obtainable from the gas, and on testing No. 4 and No. 5 flat flame jets with 16 and with 14.5 candle gas respectively, there is practically hardly any difference in the light emitted. It will take years to educate the consumer sufficiently in the methods of burning coal gas to cause the flat flame burner to be generally discarded, and during this period he will be no sufferer by the change, whilst with the regenerative and incandescent burners which will eventually take the place of the flat flame any difference will disappear.

In the regenerative burner the increase in illuminating value is almost entirely due to the rise in temperature causing methane, which forms about 34 per cent. of the coal gas by volume, to become a very valuable illuminant, and as there is just as much or more methane in the unenriched gas, it is manifest that this increase will still be found.

In the incandescent burner, the coal gas is burnt in an atmospheric burner, and the non-luminous flame is made to heat a mantle of refractory material up to incandescence; and for this purpose the 14.5 candle gas will do as well as the 16.

I have also shown that, in the distribution of coal gas, a 16 candle gas loses some of its value by condensation and the skin friction which it encounters in the small and exposed pipes; and one argument which has been raised against the lowering of the standard is that if a 16 candle gas is reduced to 15 candles during distribution, a 14¼ candle gas will be lowered to 13¼. This, I think, is a mistake. An enriched gas is lowered in illuminating value, because certain vapors are condensed from it; but it will be found that, with an unenriched gas made at a high temperature, this action is decreased to a minimum, on account of the small proportion of vapors present.

It is to the interest of the gas consumer and gas company alike that the price of gas should be reduced to the lowest possible figure, and it seems to me that the possibility of reduction in price is dependent upon the discarding of the costly enrichment.

In concluding this account of the present condition of the London gas supply, I can only say that in no city in the world is the purity and illuminating value of the gas more rigorously looked after than in London, and in no city in the world do the gas companies more loyally strive to fulfill all the obligations placed upon them.

## The Expense of Running Electrical Engineering Businesses.

Mr. Sydney F. Walker, says in the London *Electrical Engineer:* Probably few electrical engineers, except those who have been in business for a number of years, appreciate how very heavily all electrical engineering work is handicapped by the dead expenses involved in carrying on the work. The remark is true of all engineering businesses, but particularly of electrical engineering. Even the rapid advances of which all electrical engineers are so proud, add considerably to the cost of working. Some new improvement is made, and not only patterns and drawings, but perhaps a lot of finished work becomes dead stock, of the value of old metal. When, too, as is constantly happening, one firm works out an improvement in some part of their apparatus, every other firm making the same class of apparatus must follow suit, no matter at what cost, or be left out in the cold when orders are given out.

It must be borne in mind, too, by those who think electrical engineering businesses so many veritable Eldorados, returning enormous profits upon small outlay, that the proprietors of an electrical engineering business have to make good, not only their own slips, but those of all their employees, and often those of the employees of other firms. To be successful, you must follow your work, see it kept right, no matter what it costs, or into whose hands it goes. If you do not, any breakdown is attributed, not to the apparatus being improperly looked after, but to the apparatus itself being improperly made. And unfortunately, too, electrical engineers are very much like women, in that they are rarely able to see any good in each other's work. Few electrical engineers, if called in to repair the work of another firm, can resist the temptation to condemn the rival firm's work. And so all these little things cost money, and a good deal of it. And besides all these, as every electrical engineer of experience knows, every now and then something turns up, some new development of the laws of the science that had not

occurred to anyone before, that often appears at first sight to be contrary to those laws, but which always lead to one result—additional expense, more or less heavy, for the manufacturer or contractor.

And the above are in addition to the regular expenses of all properly conducted businesses. Keeping accounts so that you may know what you are owed, and what you owe, and what your expenses really are, is an important and often a very heavy item in proportion to the business done. Even the correspondence of electrical engineers in business is heavier and more costly than that of other businesses. The thing is new, and buyers often require to be very sure of their ground. Misunderstandings are more likely to arise over work that is quite new to one of the parties concerned than where both are familiar with the principal details. And this necessitates the treasuring up of every letter that one has written or received for years after.

Securing orders is also, if one may judge by what one sees in other lines of business, a far more expensive matter in electrical engineering than elsewhere. Electrical engineers themselves are, perhaps, to blame for a large part of this. No sooner is it known that an order is in the market than the representatives of several firms rush for it, each bent on belittling all his rivals. Tenders, too, are a constant source of expense, and the writer believes affect electrical engineers more severely than other business. People do not scruple, apparently, on the plea of asking for a tender, to put several firms to heavy expense, often without the slightest intention of employing any of them; sometimes even merely with a view to obtaining information.

All of these things, and many others, cost money, and unfortunately the sum of them, when added up, bears a very heavy proportion to the amount of business done. With limited companies the proportion is usually even higher.

The writer's object in penning this article is to endeavor to deter those who are engaged in electrical engineering businesses from the stupid practice of cutting prices. If you are to make a moderate profit out of your business, you must have a certain average rate of profit on your transactions, such that the sum it furnishes in the year will cover your expenses and leave you your modest profit. If you attempt to cut below this figure, whatever it may be, you will lose money and your business. If you attempt to cut your coat to your cloth, or, in other words, to make a profit by inferior work or materials, you will lose your business as soon as the results of your work have had time to show themselves. If you simply take the loss, carrying out the work as it should be done, you will lose your capital.

If anyone will look round at the firms that are now in existence that were in existence 10 or 20 years ago, he will find two characteristics invariably present. The work of these firms has been invariably good, and their prices have been high in comparison with those of other firms since deceased. These firms—those that are still standing—have marched well abreast of the times. Research and practical work have always gone together, and the research has been paid for, as it should be, out of the profits made on the practical work—that is to say, by the purchaser, for whose benefit the research was undertaken.

Young engineers, too, often fancy that they have a heaven-born genius for conducting business. No special knowledge is supposed to be required, no training, for what is perhaps the most difficult work that one can put one's hand to. Often the youngster thinks he will make up for the want of experience, both in business and in engineering, by the exercise of the very worst quality that a business man could be cursed with—that quality of sharpness, of overreaching, that so many mistake for the necessary business quality of shrewdness—forethought. There is no necessity for any young electrical engineer who knows his work to go into business for himself. There are plenty of openings for properly trained engineers. An electrical engineer has only to master his work, as far as it is known, to strike a line for himself, and to go on working away as hard as head and body will let him, continuously, and he will be bound to succeed in the end. This success, too, will come at a time when he will most appreciate it, when nature begins to warn him that the pace must not be so rapid, and in consequence of his success it need not be so rapid. If he goes into business and does not succeed—and few can—he will find himself thrown out of the race, and that many whose abilities were not equal to his have passed him, just as the hare found when he raced with the tortoise. We are apt not to look upon the tortoise as an animal to be admired, nor as one whose ways we should emulate, yet the way of the tortoise in the fable is the way to success in electrical engineering. Strike a bee line, as the American would say, and keep on pegging away.

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THE Brampton (Ont.) gas works were badly scorched by a fire which occurred on the night of the 3d inst. The damage is put at $6,000.

## Measurement of the Electric Current.

[By MR. NELSON W. PERRY, E. M., in *Engineering Magazine*.]

What, measure an invisible, intangible, imponderable something whose exact nature we confess we do not yet understand? Yes, and and measure it more exactly and more easily than we can coal or heat or light. Though it is invisible we may measure it by its appearance; though intangible we may measure it by its touch; though imponderable we may measure it by its weight. We may measure it in quarts, yards, pounds, candle power, in horse power, by the the thermometer, by cubic feet, and, in fact, in almost any way in which visible, tangible, ponderable entities are measured.

This seems to be a most anomalous statement, but it is nevertheless true. It will be made more clear, however, when it is stated that the methods of measurement are in accordance with the scriptural rule: "By their works ye shall know them." It is not electricity itself that we measure in the units above mentioned, but the results which are produced by this mysterious something when allowed or caused to act in various ways. For instance, it is an axiom that like causes produce similar results. It follows that if we multiply these causes the results will bear some definite relation to the multiplied cause, and, if we can discover what this definite relation is, the first result may be taken as a unit by which to measure the second result. Sometimes this relation between multiple causes and their effects is quite simple while at other times complex, but they have now been so carefully studied that they are pretty well understood. Thus of the simple relations, we now know definitely that the amount of gas liberated in the decomposition of water by the electric current (electrolysis) is directly proportional to the current. Therefore, if one current liberates twice as much gas in a given time as another, we know that the former was twice as large as the latter. In this case, if the smaller current liberated 1 cubic inch of gas, one might with propriety say that 1 cubic inch of electricity had passed in the latter and 2 cubic inches in the former. The amount of a given metal, too, which is deposited from solutions in given periods of time is directly proportioned to those currents, and if this be weighed, current might be considered as measured in pounds and ounces.

As an illustration of the more complex relations between cause and effect, may be mentioned the production of heat in a conductor by a current passing through it. Double the temperature no longer indicates that twice the current is passing, however, for it takes very much less than double the current to produce double the heat. It has been found that the heating effects of electricity are proportioned to the *square* of the currents passing, viz., that 2 units of current will produce 4 times as much heat as 1 unit, and 3 units 9 times as much. Where electricity is employed to produce light, the relations are still more complex, the illumination varying about as the fifth power of the current. If these relations are perfectly definite we can measure the current in the former instance by degrees of temperature, and in the latter by candle power.

Of two clocks which normally run synchronously, if one be retarded or accelerated by the passage of a current through a neighboring electromagnet or otherwise, if we introduce a planetary movement into the clock mechanism, it may be made to revolve a spool or drum upon which will be wound or unwound a tape or string, and when we wish to know how much current we have consumed we may measure it off in yards or inches, or more directly from the clock dials, in hours and minutes, which are the measure of the retardation or acceleration of one clock over the other.

Thus we may use any of the effects of the electric current which lend themselves readily to measurement as substitutes for their causes and express the values of the currents in any of the units by which the effects themselves are usually measured. In this way we have the choice of an almost infinite variety of metering methods depending upon the well known properties of electricity.

Among the properties of electricity most usually relied upon to enable us to measure it are—

1. Its property of producing magnetism.
2. Its property of causing a freely suspended magnet to take up a position at a greater or less angle to the direction of the current.
3. The property of the mutual attraction and repulsion of currents.
4. The suction of a solenoid traversed by an electric current upon a magnetic ore.
5. The elongation of a wire due to the heat caused by the passage of current.
6. The electrolytic decomposition of liquids or solutions.

The method of determining results by indirect methods so generally employed in electrical measurements is not necessarily a source of in-

accuracy or uncertainty, nor is it unique in exact science. In chemistry, for instance, it is the exception rather than the rule that an element or base is determined directly. The constituent sought is usually precipitated and weighed as a salt of known composition, and, from the weight of this salt, the weight of the element to be determined is obtained by calculation.

Current can be measured either absolutely or relatively. The absolute determinations are exceedingly difficult, requiring the most painstaking care, often extending over months of time. As an illustration of the difficulties of absolute determination it may be mentioned that the Committee of the British Association appointed to redetermine the value of the absolute unit of resistance made an error of 1½ per cent., so that the old unit was only equal to .9866 of the new unit. It is a method that should be relegated to the scientist, or rather to a committee of scientists, thoroughly skilled in such work, and has no interest either to the engineer or the lay public. On the other hand, the relative determination is so easy that a lecturer on this subject, Professor Francis B. Crocker, once said he thought that a telegraph boy, after a short period of instruction, could make a measurement with an error not to exceed $\frac{1}{10}$th of 1 per cent., and that a student might do somewhat better after a month's instruction. It is the relative determinations, therefore, with which this paper will deal. The six different properties of the electric current mentioned above, upon which we depend for these determinations, all involve either one or the other of four fundamental principles, viz, electro magnetic, electro dynamic, electro chemical and electro thermal. Upon these four principles depend all the various forms of measuring instruments.

Of the electro magnetic instruments, perhaps the best example and the simplest is what was known as the Bergman or Edison ampere meter, which consists of a coil of wire which, when traversed by a current, draws an iron armature within itself as the current increases, and by this motion causes a needle to pass over a dial that has been calibrated from some reliable instrument.

It must be borne in mind that, as in everyday life we have need of hay scales as well as chemical balances, so we have use for electrical instruments which give but approximate results as well as those of the utmost delicacy. Instruments of the kind just mentioned are the hay scales of electrical instruments, but they find great use in central stations and electric street railway power houses where current is turned out at wholesale and approximations to the amounts only are desired.

One of the great faults of instruments of this kind and one which prohibits their use for more accurate determinations, is that the readings of an increasing current differ from those of a decreasing current. This is due to the iron core which introduces what Professor Ewing calls *hysteresis*, which is the lagging of a magnetic effect behind its cause. That is to say, if the current should suddenly increase, owing to the magnetic sluggishness of the iron core, the instrument would not register quite as high as it should, and, if the current should then suddenly decrease to its former quantity, for the same reason the instrument would not read as low as it should; its reading on an increasing current would be lower than its reading for the same current that was decreasing from a higher value.

The instruments constructed on the electro dynamic principle, of which the Siemens electro dynamometer and the Thomson balance are examples, and which depend for their action upon the mutual attraction and repulsion of currents, do not have this defect, since they contain no iron in their construction.

A difficulty presents itself with instruments of this class also. Owing to the fact that that the mutual reactions of currents are not proportional to the currents themselves, but to the squares of the currents, the graduations on the dial plates are not equal for equal increments, but increase very rapidly from very small to very large divisions. They possess, however, the very important advantage, which some classes of instruments do not possess, of being equally applicable to the measurement of both direct and alternating currents.

Under the head of electro chemical meters come those which depend upon the power of an electric current to decompose liquids and solutions of metallic salts. As they liberate gases by this process, or deposit metals, they are called gas or metallic voltameters. If the former, the gas is usually measured; if the latter, the metal is weighed. The gas voltameters have very little practical interest, but the metal voltameters have come into very extensive use. The best known meter of this class is the Edison meter, which consists of two amalgamated zinc electrodes immersed in a solution of sulphate of zinc. The action of the current is to cause a transfer of metal from one electrode to the other. Since the amount of metal deposited on the one or dissolved from the other is exactly proportional to the current, the gain in weight in the one or the loss in the other is an exact equivalent of the current passing. In order that the whole of the energy of the current shall not be consumed in the operation of measuring it, as would be the case were it all passed through the voltameter, the latter is placed in a shunt circuit whose resistance is so proportioned that it will take off but $\frac{1}{99}$ part of the current. As a means of check, two voltameters are always placed in each circuit in parallel, and since the Edison current is usually distributed by the 3 wire system which extends into every customer's house, and which really constitutes two circuits, the Edison meter as installed consists of four voltameters—two for each circuit. In reading the meters for the determination of the bills, a losing zinc of one bottle and a gaining zinc of the other, of each pair are weighed, the one as a check on the other. Since a change of temperature affects the conductivity of metals and liquids in exactly opposite ways, though in different degrees, a neat method of compensating for temperature is resorted to. This consists in introducing into each bottle circuit a coil of copper wire of such length that the loss of conductivity of the metallic portion of the circuit by increase of temperature will just balance the gain in conductivity in the liquid portion due to the same cause.

While this meter is capable of giving quite accurate results under favorable conditions, the conditions of commercial use are not such as to make it really an instrument of precision, but it is accurate enough under these conditions for all practical purposes, the range of error rarely exceeding 2 per cent. As indicating into what general use this meter has come, it may be stated that in New York city alone 200,446 16-candle power incandescent lamps, 2,680 arc lamps, and 6,117$\frac{95}{100}$ horse power of motors are supplied from 5,500 Edison meters. It may be interesting in this connection to show how the bills are made out from this meter after the zincs have been weighed.

One ampere hour of current will deposit 1.224 grams of metallic zinc. But since only $\frac{1}{99}$ part of the whole current used passes through the voltameter, the amount of deposit which will represent an ampere hour of current will be $\frac{1.224}{975}$. The Edison Company sells current in lamp hours, viz., using the amount of current consumed in one hour by a 16-candle power lamp as its unit, and charges for this 1 cent. A 16 candle power lamp requires .424 of an ampere of current, therefore the weight of zinc deposited per 16-candle lamp hour will be $\frac{1.224}{975} \times \frac{424}{1,000}$, and there will be as many lamp hours for every gram of zinc deposited as the result of the multiplication of these fractions is contained into 1. This may be expressed thus:

$$\frac{1}{\frac{1.224}{975} \times \frac{424}{1000}} = \text{number of lamp hours per gram of zinc deposited,}$$

and this at 1 cent. per lamp hour equals $18.75. This is what is known as the "lamp constant." By multiplying this by the number of grams and fractions of a gram deposited, the customer's bill is determined at once. It is evident that this meter cannot be used on alternating current circuits.

The thermo-electric methods are not much employed for measuring currents, but when used at all, are employed to determine the voltage. The Cardew voltmeter is the most familiar instrument built on this principle, and consists simply of a long wire through which the current passes, and which by its expansion and contraction due to the changes in the strength of the current actuates an index needle.

It is usually stated that this meter is equally applicable to either alternating or direct currents, but this is not strictly true. It may, indeed, be used for either current if properly calibrated for the current upon which it is used; but an instrument calibrated for direct currents will not give correct readings if placed on an alternating current circuit, and *vice versa*, as the heating effects of the two are not alike.

While there can be nothing simpler than the Cardew instrument, it is open to the serious objection that it consumes an enormous amount of current, relatively speaking. While on this subject of the loss of energy in measuring instruments, it may be well to refer to some remarks made by Mr. Edward Weston at the meeting of the National Electric Light Convention, held at Washington in the latter part of February and the first of March. He called attention to the fact that the losses in central stations due to the consumption of energy in the measuring instruments sometimes used, when figured out in dollars and cents per annum, was startling, and cited an instance which had come under his observation, where the loss in this one item was $89 per pear. His remarks attracted wide attention, and deservedly so, as this source of loss had been almost entirely unsuspected by most central station men.

Another class of instrument founded upon the mutual directive action of magnets and currents includes the Weston instruments. In fact the instruments of this make form a class by themselves, for while they em-

ploy both iron and magnetism, as do the electro-magnetic instruments, they are not subject to the disturbing influences of hysteresis. The magnets in this case are not electro magnets, as in the other case, but permanent magnets, and the operation of the instrument is not dependent upon changing magnetism at all. The Weston ammeter consists of a permanent horseshoe magnet having suspended between its poles a coil of very fine wire, to which the needle is attached. But a very small portion of the current passes through this coil, and the deviation of the needle is caused by the variation of the current in this constant magnetic field. Since the angle through which a coil will swing under these conditions is directly proportional to the current flowing through the coil, and not, as in the electro dynamic instruments, proportional to the square of the current, the graduations on the dial-plate are uniform throughout the whole range of the instrument. The Weston instrument cannot be used on alternating currents, nor will it register, as some other instruments do, if the current is passed through in the wrong direction. From the fact that it measures but a very small fraction of the current, the losses due to this cause are exceedingly slight. It is also extremely delicate and sensitive, although it is what is called "dead beat," which is to say that with sudden changes of current the needle does not vibrate much, but comes almost at once to rest after registering the new conditions.

The Weston instrument is a device *sui generis*, and peculiarly an American product. Mr. Weston himself is an Englishman by birth, but intensely American in feeling, and takes pride in the fact that his instruments successfully compete with the best of foreign make in their own markets. This instrument and those built on the electro-dynamic principle may properly be called the chemical balances of electrical measuring instruments.

Every electric current involves three elements: (1) The current itself, which is measured in amperes; (2) The pressure or electromotive force which gives rise to the current, measured in volts; and (3) The resistance which the conductor opposes to the current, which is measured in ohms. A current is not fully described, therefore, until all three of these elements are given, so we have instruments for measuring each of them separately. If any two are given, however, the third may be calculated from Ohm's law, which expresses the inter-relation of the three, which is that the current that will flow through a given conductor is equal to the electromotive force by which that current is urged along, expressed in volts, divided by the resistance of the conductor, expressed in ohms.

Thus far the instruments described are intended for the measurement of the current, and are called ammeters. Instruments intended to measure the electromotive force are called voltmeters. These latter do not differ in any way in principle from the former, and any instrument that can be used as an ammeter can also be used as a voltmeter, provided that only a very small proportion of the current is allowed to pass through it. The voltmeter, therefore, is chiefly distinguished from the ammeter of the same class in having long coils of very fine wire instead of shorter coils of heavy wire. A voltmeter is in fact a very delicate ammeter, and might very properly be called a mille-ampere meter. It is, in fact, sometimes so used.

Resistances are usually measured by means of an instrument known as the Wheatstone bridge. This is conventionally represented by four wires arranged in the shape of a diamond, with a fifth one, with a very delicate galvanometer in circuit, connecting the two obtuse angles of the diamond. If now the four bounding wires of the diamond have equal resistances, and the two acute angles of the diamond be connected to the two poles of a battery, the current will divide, half going around one side and half going around the other side of the diamond, and there will be no tendency for any of the current to pass through the diagonal wire. If, however, one of the two wires on one side has a greater resistance than the opposite wire on the other side, some of the current will pass through the diagonal wire and be indicated by the galvanometer. If we increase the resistance of this opposite wire so that the two are again exactly equal, no matter what the resistance may be, the diagonal current will cease. Therefore, if we place the resistance to be measured in one leg (as it is called) of the bridge, and add known resistances to the opposite leg until the galvanometer ceases to show the passage of current through the diagonal, we have the exact measure of the unknown resistance. The operation is exactly analogous to weighing on a beam balance, where the substance to be weighed is placed in one scale pan and exactly balanced by pieces of iron of known weight placed in the other. While this instrument is of great simplicity, it is also one of great delicacy and precision.

In addition to the preceding, there are a long line of instruments of other kinds, such as watt meters, sine and tangent galvanometers, and indicators of various kinds. One of the latter class, which is one of the most ingenious in the whole range of electrical measuring instruments, ought to be mentioned. I refer to what is known as the Edison indicator, though for what reason it bears Edison's name I do not know, since he had nothing to do with it. It consists of a Wheatstone bridge in the two opposite legs of which are placed incandescent lamps, and in the other two balancing coils of German silver wire; the index finger being the galvanometer needle itself. The resistance of the lamps varies rapidly with the temperature, while that of the wire remains fairly constant. If, therefore, the electromotive force on the circuit varies from that for which the German silver resistances were adjusted, the balance will be destroyed and a current will flow in one or the other direction through the galvanometer, indicating "too high" or "too low." These instruments are much used in central stations to enable the dynamo tender to regulate the pressure on his circuits.

One of the greatest desiderata in many electrical measuring instruments is a material whose electrical resistance shall not vary with the temperature. For a long time German silver more nearly filled the bill than any other known alloy, but it remained for an American, Mr. Edward Weston, to invent an alloy having a zero temperature coefficient—which means that the electrical resistance of this alloy does not vary at all with increase or decrease of temperature. The credit for this has been usurped by foreigners, but the honor is due to America.

## The Prepayment Meter System.

[A Paper Read by Mr. G. J. Gough before the Southwest of England District Association of Gas Managers.]

Two years ago, at the meeting of the Association at Bristol, I read a short paper upon the question of extending the supply of gas by the provision of fittings in small houses, in connection with the subject of short period collections, or of prepayment by means of the prepayment meter then recently introduced. At that time my directors were proposing to undertake the fitting up of small houses; but they had not yet entertained any idea of the prepayment meter. I then expressed the opinion that the prepayment system would not answer in small towns, such as Calne, and advocated a short period collection in preference. I am afraid I had not given the question a sufficiently mature consideration, for the meeting was scarcely over when I began to realize that there was much to recommend the prepayment system to the class of householder which my directors proposed to supply with fittings, and that my fears were not warranted. Instead, therefore, of returning home to put into practice a short period collection (in my case meaning something shorter than a quarter, as we collect quarterly), I straightway opposed the idea, and advanced the prepayment system, which I am glad to say my directors decided to adopt, with what results it will be object of this paper to show.

A circular was issued early in July, 1892, stating, among other things, that "with a view to bring gas within reach of all persons and to promote its more general use in small houses, the Calne Gas and Coke Company, Limited, are prepared to lay on fittings for lighting two rooms, also for a boiling or frying stove, and to supply the stove and keep the whole in order, upon condition that a prepayment meter be used—charging only a small percentage upon the outlay, to be included in the price charged for the gas."

In response to this circular some 30 applications were received. They were not all proceeded with immediately, it being considered advisable to advance cautiously, lest the system should prove unsatisfactory or unpopular. The first dozen instalments were completed in the following September, the remainder soon following; and we have now 50 houses so fitted up, and 20 more in hand.

There has been only the one circular issued, and no attempt whatever has been made to push the system. Its own merits, practically unadvocated on the part of the company, have themselves secured its acceptance to the extent mentioned; and this fact is alone sufficient to prove the success of the scheme with the consumer. If my directors desired to advance faster I have no doubt whatever that, if actively sought for, another 50 householders might at once easily be found willing to have the instalments made; but my directors prefer to let the system work its own way, as it is now doing, which is perhaps the better course to pursue.

Now as to our working experience. Taking the first page of the prepayment rental, which comprises 32 accounts, we find that the consumption of gas for the year ended at Lady-day last was 197,400 cubic feet; giving an average of 6,168 cubic feet per consumer. These consumers all occupy houses at a rent of not exceeding $50 per annum—the major-

ity at a rent of not more than $40 per annum. They include 3 laborers, whose wages do not exceed $3.75 per week; 21 butchers, mechanics and others of the artizan class, whose wages range from $4.50 to $7.50 per week, and 8 small shopkeepers.

If a comparison be made with 32 similar consumers, under the old system, taken at random from the rental, it will be found that the consumption for the same period was, in their case, 120,900 cubic feet, or an average of 3,778 cubic feet per consumer only, as against the 197,400 cubic feet and 6,168 cubic feet respectively—showing a consumption of 63.27 per cent. in favor of the prepayment consumer. I have carried the comparison into further detail, and find that the percentage of increase in the summer half was 96.45, and in the winter half 41.5. The actual figures were: Summer half—old system, 47,900 cubic feet, with an average of 1,496 cubic feet; new system, 94,100 cubic feet, with an average of 2,940 cubic feet. Winter half—old system, 73,000 cubic feet, with an average of 2,281 cubic feet; new system, 103,300 cubic feet with an average of 3,228 cubic feet. This large summer consumption is a most satisfactory feature. It is no doubt to be attributed to the small boiling rings, which, as before mentioned, are supplied in every instalment under the prepayment system; while they are not in general use under the old system. I may, however, parenthetically remark that we now supply these small boilers gratuitously to all consumers. The price charged for the gas under this new system is the same as to ordinary consumers, with a small addition, to provide a percentage on the outlay and to meet repairs and renewals. The cost of the instalments averages $17.30, and this includes pipes and fittings for sitting room and kitchen (one pendant and one bracket), also a boiling stove, a shelf for the stove, a 3 light meter, with a shelf to carry it, and a meter tap.

The price of gas at Calne was 93 cents per 1,000 cubic feet. The meters were adjusted to supply 17½ cubic feet for 2 cents, equal to 1,000 cubic feet for $1.16, and this gives a margin of 22 cents per 1,000 cubic feet, which yields, with the consumption of 6,168 cubic feet per householder, 8 per cent. on the outlay. My directors intended to adjust the price so as to obtain a return of 10 per cent. upon the outlay beyond the profit on the gas sold. With the present consumption, and adjustment of the meters, the return is scarcely so much; but it is very near it. I should not recommend a reduction in the quantity supplied per penny, but rather that the consumer be given the benefit—remembering that he makes no bad debts, and that the collection is comparatively easy.

The system, then, has answered admirably in Calne, and the number of small houses supplied with gas has increased 24 per cent. Taking the whole 70 cases, our total number of consumers has been increased by 18.18 per cent.; the total consumption (assuming the average mentioned is maintained) is already increased by 5 per cent., and the Company may take some credit for having provided a way of bringing the use of gas within reach of all classes, and, in so doing, are making a proper use of the monopoly which they possess of supplying this particular article of light

We have not introduced the prepayment meter in connection with the old system. But we have used it in a few cases, where consumers like to keep their money as long as they can, and give you as much trouble as possible to get it, or will not let you get it all; and we have found it particularly efficacious.

*Discussion.*

The President (Mr. N. H. Humphrys) thanked Mr. Gough for his very interesting account of a very instructive experiment. He regretted that the previous proceedings had thrown the paper so far back in the programme that some of their friends had had to leave without hearing it.

Mr. T. W. R. White (Sherbourne) said he was not in a position to say much about the subject on the lines taken by Mr. Gough. What he had done he had done from necessity. When they had a bad payer, after a certain date notice was given that a prepayment meter would be fixed, and after that they had no difficulty. In each case the consumer was fairly responsive in the use of gas, and the system paid pretty well. They charged the same rate to the prepayment consumer as to the ordinary consumer, and charged the meter rent at the end of the quarter, because the prepayment consumers objected to pay more than other people. Perhaps in Calne there were houses which lent themselves more readily to the supply of fittings on the hire system. In Sherborne they were confining themselves mainly to the houses of small consumers and especially to those consumers who gave them trouble in the collecting of the accounts. He thought many of them might make experiments with the system so that they might help one another by a relation of their experiences.

Mr. D. Irving (Bristol) congratulated Mr. Gough upon the success he had achieved. Mr. Gough's communication was just the paper which they, as an Association, wanted; being the relation of the results of a practical experiment which had extended over a considerable period. Such papers could not fail to be of advantage to them all. By an arrangement which was self-supporting Mr. Gough had succeeded in increasing the number of his consumers by 18 per cent. and his sales of gas by 5 per cent. But he thought he ought to be credited with more than 5 per cent. increase in sales, because they all knew that the exceptionally fine weather of last year had tended to restrict the consumption of gas. Notwithstanding this adverse influence, Mr. Gough had increased his sales by 5 per cent. This, he thought, was indisputable evidence of what could be done with the system, and of what really could be done when gas managers put their shoulder to the wheel.

Mr. J. Griffin (Fareham) said that in Fareham the electric light had taken the whole of the public lighting from them, and a large number of houses had gas services laid out but did not use gas. He had thought that if he could get these people to use gas it would be a good thing, and he advised his Directors to get a prepayment meter for a trial. The meter was obtained, and for a week it worked fairly well; but then it got out of order, and they could not do anything with it. If a reliable prepayment meter was available he should like to get hold of it. They had 400 consumers, 100 cooking stoves, and some 60 regenerative lamps, and they had done all they could to compete with the electric light. He did not think there were many places where the whole of the public lighting had been taken from the gas company, as in Fareham, and they had still got their heads above water; the supply to the forts helping them considerably.

Mr. H. Sainsbury (Trowbridge), said he found that when a prepayment meter was fixed the consumer used a great deal more gas than before. One or two customers had used thousands more than they would otherwise have done. He thought there was a great future for the prepayment meter. It did not at present work quite smoothly, but he thought all difficulties of that kind would soon be overcome.

The President said he had had no experience of the system.

Mr. Gough, in reply, said those who had spoken, particularly Mr. Sainsbury and Mr. White, had lost view of the object which they had in Calne. It was not to get old consumers to pay better, but to get new consumers. By this venture—letting out fittings and setting prepayment meters—they had extended the use of gas to a considerable extent. Mr. White had mentioned the collection of meter rents at the end of the quarter. Of course, the system ought to be varied to suit local circumstances, but he did not think Mr. White's system would suit in his case. A man, he thought, preferred to know what he had to pay and be done with it; and he (Mr. Gough) much preferred to add something to the price of gas to cover the meter rent.

Mr. White said the meter rent was collected on inspection.

Mr. Gough said the meters did not give the utmost satisfaction, but there was nothing very alarmingly wrong with them. On the whole, he was satisfied with their working; still there was some room for improvement. Occasionally a meter got choked with a number of coppers; for it was an actual fact that people were so anxious to put their money in that they even forgot to turn the handle. People whom they would never imagine as using gas, and whom they might think were unable to pay, were the largest consumers. The greatest difficulty they had to contend against was the collection of the money. They required a large bag to hold the coppers, and then they had the trouble of getting rid of them.

## The Fusibility of Clays.

[By Mr. H. A. Wheeler, in *Paving*.]

In connection with the investigation of the clays of Missouri, a large amount of experimental work has been done for determining their fusibilities and other properties. The following considerations are the outcome of this work:

Bischof, in his "Feuerfesten Thone" (p. 71), gives a formula for calculating the fusibility of a fireclay from a chemical analysis, which is based on the statements that the pyrometric value depends on:

1. The relation of the alumina to the fluxes (or detrimentals).
2. The relation of the alumina to the silica.

From this he derives the following expression for representing what he calls the "Feuerfestigkeitsquotient," or fusibility quotient: F. Q. $= \frac{\text{Alumina} \times \text{alumina}}{\text{Silica} \times \text{fluxes}}$. The value of F. Q., he finds to be 14 for the most refractory clays (Saarau, with 1.26 per cent. of detrimentals); about 9 for pure kaolins (Zetlitz, with 2 per cent. fluxes), 4 for Belgian fireclays (3 per cent. fluxes), and 1 or less for the Rhine fireclays, which have 4 to 7 per cent. of detrimentals. From Bischof's statement it follows that the more aluminous a clay is the more refractory it will be, while the

*Table Showing the Value of Calculated Fusibilities.*

| Name. | $SiO_2$. | $Al_2O_3$. | $H_2O$. | Total N. | Alkalies D'. | Total D. | Sp. Gr. | Grain. | Fusibility, F.° | | | Calcu'ated Values. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Incip. | Complete. | Scor. | Bischf. F. Q. | Wheelers. A. | Wheelers. B. |
| St. Louis Fireclays— | | | | | | | | | | | above | | | |
| Christy, washed | 64.35 | 21.16 | 8.94 | 94.45 | 0.51 | 4.81 | 2.13 | Fine. | 2200 | 2400 | 2700 | 1.44 | 17.7 | 13 0 |
| " mine run | 61.73 | 23.56 | 9.25 | 94.54 | 1.00 | 7.30 | 2.47 | Coarse. | 2100 | 2300 | 2500 | 1.23 | 11.4 | 10 2 |
| Jameson's, washed | 58.61 | 27.36 | 11.13 | 94.10 | 0.71 | 5.25 | 1.92 | " | 2200 | 2400 | 2700 | 2.47 | 15 8 | 11.8 |
| " mine run | 53.90 | 28.85 | 11.61 | 94.36 | 0.85 | 6 86 | 2.40 | " | 2200 | 2400 | 2600 | 2.33 | 12.2 | 10 9 |
| Sattler, washed | 52.98 | 28.77 | 11.42 | 93.17 | 1.01 | 5.12 | 2.40 | Fine. | 2200 | 2400 | 2700 | 3.44 | 15.2 | 11 4 |
| " mine run | 51.66 | 30.78 | 11.86 | 94.30 | 0.99 | 5.88 | 2.40 | " | 2100 | 2300 | 2500 | 3 06 | 13.7 | 10 6 |
| Parker & Russell | 67.47 | 19.33 | 7.73 | 94.53 | 1.07 | 5.14 | 2.44 | Very coarse. | 2250 | 2450 | 2700 | 1.08 | 15.2 | 13.3 |
| Laclede | 57.34 | 24.68 | 11.55 | 93.57 | 0.67 | 6.30 | 2.45 | Coarse. | 2250 | 2450 | 2650 | 1.69 | 12.9 | 11.1 |
| Evans & Howard | 59.36 | 23.26 | 10.20 | 92.82 | 0.63 | 5.67 | 2.41 | " | 2250 | 2450 | 2650 | 1.64 | 12.7 | 11.3 |
| "Rock" or Non Plastic Fireclays— | | | | | | | | | | | over | | | |
| Pendleton | 46.18 | 38.12 | 14.01 | 98.31 | 1.20 | 1.06 | 2.42 | Fine. | 2300 | 2500 | 2700 | 16 00 | 28 0 | 18.0 |
| High Hill | 45.12 | 40.46 | 13.34 | 98 92 | 0.30 | 1.06 | 2.33 | Very fine. | 2350 | 2550 | 2700 | 37.00 | 73.0 | 29 0 |
| Drake | 40.50 | 43.22 | 14.15 | 97.87 | 0.51 | 1 93 | 2.35 | " | 2300 | 2500 | 2700 | 23.00 | 40.0 | 22.0 |
| Truesdale | 43.56 | 41.48 | 14.05 | 99.09 | 0.20 | 1.00 | 2 45 | " | 2300 | 2500 | 2700 | 40.00 | 82 0 | 31.0 |
| Union | 44.14 | 39.86 | 13.84 | 97.84 | 0.76 | 2.45 | 1.98 | Fine. | 2200 | 2400 | 2700 | 15.00 | 31.0 | 18 0 |
| Owensville | 44.70 | 35.92 | 12 62 | 93.24 | 0.29 | 6.85 | ..... | " | 2050 | 2200 | 2350 | 4.00 | 11.0 | 9.0 |
| Sankey's | 50.18 | 33.02 | 11.88 | 95.07 | 2.06 | 5.29 | 2.10 | Coarse. | 2100 | 2300 | 2500 | 4.00 | 13.0 | 10.0 |
| Kaolins— | | | | | | | | | | | | | | |
| Glen Allen | 72.34 | 18.94 | 7.04 | 98.28 | 0.42 | 1.89 | 1.89 | Very fine. | 2200 | 2400 | 2600 | 2.7 | 42.0 | 15.6 |
| Sterling | 57.75 | 27.60 | 11.43 | 96.78 | 0.60 | 3.24 | ..... | " | 2200 | 2400 | 2600 | 4.3 | 26.0 | 12.3 |
| | | | | | | | | | | | above | | | |
| Cape Girardeau | 91.05 | 5.01 | 2.74 | 98.80 | 0.12 | 1.27 | 2.02 | " | 2200 | 2400 | 2600 | 0.2 | 70 0 | 22.0 |
| Winona | 56.74 | 27.29 | 7.40 | 91.43 | 1.21 | 8.52 | 1.86 | " | 1800 | 2000 | 2200 | 1.5 | 9.6 | 7.0 |
| Potters' Clays— | | | | | | | | | | | | | | |
| Guthrie | 47.13 | 34 98 | 13.88 | 95.99 | 0.52 | 3.76 | 2.13 | Very fine. | 2000 | 2200 | 2400 | 6.5 | 22.0 | 13 0 |
| Mammoth | 49.04 | 34 85 | 12.33 | 96.22 | 0.85 | 3.93 | 1.69 | " | 1800 | 2100 | 2400 | 6.3 | 20.0 | 11.0 |
| Commerce | 71.78 | 17.01 | 8.13 | 96.92 | 0.78 | 3.56 | 2 03 | " | 1950 | 2150 | 2350 | 1.0 | 22.0 | 13.0 |
| | | | | | | | | | | over | over | | | |
| Clapper | 67.76 | 21.96 | 8.23 | 97.95 | 0.24 | 2.13 | 2 45 | Coarse. | 2500 | 2600 | 2600 | 3.7 | 46.0 | 27.0 |
| Deepwater | 74.02 | 15.26 | 3.69 | 92.97 | 2.37 | 5.38 | 2.37 | Fine. | 2100 | 2300 | 2500 | 0.6 | 12.0 | 10.6 |
| Brick Clays (Loess)— | | | | | | | | | | | | | | |
| Kansas City | 72.00 | 11.97 | 6.42 | 90.19 | 3.25 | 10.11 | 2.17 | " | 2000 | 2200 | 2300 | 0.2 | 6.8 | 5.7 |
| Hartwell | 60.93 | 21 51 | 5.30 | 87.64 | 2.03 | 10.15 | 1.80 | " | 1850 | 2050 | 2150 | 0.7 | 7.2 | 5.4 |
| St. Louis | 73.92 | 11.65 | 5.26 | 90.83 | 3.13 | 9.90 | 1.98 | " | 1800 | 2000 | 2100 | 0.2 | 6.8 | 5.3 |
| Shales— | | | | | | | | | | | | | | |
| Moberly | 65.01 | 19 34 | 6.54 | 90 85 | 2.60 | 9.31 | 2.41 | Coarse. | 1850 | 2050 | 2250 | 0.6 | 7.5 | 7.0 |
| Kansas City | 54.80 | 23.73 | 6.00 | 84.53 | 3.80 | 15.34 | 2.37 | Very fine. | 1500 | 1700 | 1900 | 0.7 | 4 4 | 4.0 |
| Deerfield | 58.90 | 21.38 | 8.69 | 88 97 | 1.52 | 10.84 | 2.43 | Medium. | 1800 | 2000 | 2200 | 0.7 | 7.3 | 6.5 |
| Louisiana | 57.01 | 24.43 | 7.63 | 89.07 | 3.81 | 11 47 | 2.39 | Coarse. | 1600 | 1800 | 2000 | 0.9 | 5.8 | 5.5 |

more siliceous or the more impure with detrimentals the less refractory it will be.

While high alumina is indicative of purity in a clay, yet the work on Missouri clays shows no less in refractoriness when the alumina is replaced by sand, or the clay is very siliceous, while every increase in the detrimentals decidedly affects the fusibility, especially if the increase is in the alkalies. But the work on the Missouri clays shows that density and fineness of grain have also a very important influence on the refractoriness, and these must be considered in weighing the value of the detrimentals present in a clay. Hence Bischof's formula will be totally unreliable, even in clays of similar density and fineness, on account of confusing the silica and alumina as such vital factors of fusibility, when it is mainly, if not entirely, a question of fluxing impurities, density and fineness. When clays are similar in density and fineness, the refractoriness will be inversely as the detrimental impurities, when the latter are equated as to their proper fluxing values, and if this is called the "fusibility factor," it may be expressed by the following formula:

$$\text{F. F.} = \frac{N}{D \times D'} \qquad (A)$$

in which N represents the sum of the non detrimentals or total silica, alumina, titanic acid, water, moisture and carbonic acid; D represents the sum of the detrimental impurities, or the iron (as sesqui-oxide), lime, magnesia, alkalies, sulphuric acid, sulphur, etc.; D' represents the sum of the alkalies which have been found to have about double the fluxing value of the other fluxes; ferrous oxide is probably about as objectionable, but as it usually oxidizes up into much less fusible form of sesqui-oxide in the operation of burning the clay, it is not thus accented in ordinary coarse clays. This formula will be found to give a fairly good comparative value of the refractoriness of clays that do not differ more than 0.2 from one another (the closer the specific gravity the more reliable the comparison) in density, and are of similar fineness of grain. When the clays to be compared differ in density and fineness, then it is necessary to modify formula A by a constant, C, that will have different values depending on the density and fineness, so the formula will be:

$$\text{F. F.} = \frac{N}{D \times D' \times C'} \qquad (B)$$

in which N, D and D' will have the same values as in formula A; C = 1 when the clay is coarse grained and specific gravity exceeds 2.25; C = 2 when clay is coarse grained and specific gravity ranges from 2 to 2.25; C = 3 when it ranges from 1.75 to 2; C = 2 when the clay is fine grained and specific gravity is over 2.25; C = 3 when it ranges from 2 to 2 25; and C = 4 when it is from 1.75 to 2.25. These values of C are only crudely approximate, as not enough work has been done on a sufficiently large variety of clays to give satisfactory values, while no simple method has been, as yet, arrived at for giving a ready and correct expression of the fineness. Still, enough work has been done to show that formula B is the only one that can be used indiscriminately on all kinds of clay, though a very large amount of work has still to be done to arrive at more reliable values for C and the fineness, as the large number of factors involved makes it a very complex question.

In the table of analyses given herewith examples have been selected from the 110 samples of the Missouri clays that have been completely studied, which fairly illustrate the unreliability of Bischof's formula, the quite satisfactory comparative values given by formula A on clays that are physically similar, and the much more general scope of formula B, which considers physical as well as chemical influences, though it also shows the need of further work to obtain more reliable values for the constant C. Thus, in the St. Louis fieclays, which are all obtained from the same seam, Bischof's formula gives about equal values (1.23 to 1.44) to clays of very different fusibility, and very different values (1.08 to 3.44) to clays of about equal fusibility; the Cape Girardeau kaolin (91.05 per cent $SiO_2$ and 1.27 per cent. fluxes) is given a very inferior value for its refractoriness (0.2), though (as the analysis would indicate) it could not be affected by the highest heat of the furnace, while the easily fusible Winona kaolin is given a higher value (1.5). Again, the Clapper (potter's) clay, which is one of the most, if not the most, refractory clay known, is given a value of only (3.7) by Bischof's rule, while the readily fusible Owensville fireclay has a value of 4. A further study

of the table will show the utter unreliability of Bischof's F. Q. as a means of arriving at the relative fusibility of clays.

The table shows that the value of F F should exceed 12 when calculated by formula A, for coarse, very dense clays, or exceed 10 when using B, for a refractory clay; and the higher the value, the more refractory it will be. It should be remembered in consulting the table that no matter how reliable a pyrometer may be—and the best of them need much care and attention—it is difficult to determine just what the temperature of a clay is, when it begins to change, on account of its very poor conductivity of heat; differences of over 100 F. were found within less than half an inch on the same bricklet. In burning a clay, it slowly shrinks and becomes harder as the temperature is raised above a red heat (when it begins to lose its chemically combined water), and at a certain point the granular structure of the raw clay can no longer be distinguished, and it is now found to have a hardness of 6 to 6.5; this is called the point of incipient vitrifaction (in the table), or fusibility, and it is necessary to burn clay wares to this point to develop strength and hardness. If the temperature be raised still higher, it will become slightly harder, or 6.5 to 7, and at a certain point will look more or less stony or vitreous, which is called completely vitrified; at this point the clay will not soften or flow or become distorted. If the heat be still further raised, the clay will finally soften, vesicles and bubbles will begin to appear as the result of gases given off by the chemical changes that now slowly take place, and finally a very spongy, scoriaceous, pasty mass will result, unless the heat be raised so high as to thinly liquify the mass, when the gases escape and a pool of glass results. The first appearance of the bubbles is called the point of scoriaceous vitrifaction, or fusion, and shows that the clay is failing and would slowly flow or yield under pressure or abrasion. As the range in temperature is usually from 300° to 600° F. between this first or incipient point and last or scoriaceous or failing point, with a gradual transition from one to the other, it is difficult to state with any degree of accuracy just when the clay fails, and to decide any closer than a rough approximation as to when a clay gradually passes through the above three important stages in its very slow transition from a rigid solid to a very viscous liquid. Hence the pyrometric determination of these three conditions is only approximate and an error of 25° to 50° in the figures given in the table is quite possible.

Le Chatelier's thero-electric pyrometer was used in making the temperature observations, which was calibrated to show changes of 25° F., and the samples, varying from ¼ in. by 1 in. by 4 in. to 1 in. by 1 in. by 4 in., were burned in muffles and graphite crucibles that were run at different degrees of heat in coke fired assay furnaces.

## Pulverized Coal Fuel.

A writer in the *American Manufacturer* says that the suggestions for the use of pulverized coal fuel press themselves so frequently upon public attention that they seem in a fair way to become like one of the ghosts of classic fame which "will not down." The material itself appears to be so abundant in a form which is very nearly ready for use, its complete preparation seems to be so simple a matter, its distribution at the point of combustion can be so readily accomplished, and it can be so easily burned up completely without smoke and apparently without leaving any ash behind it, that it is not a surprising thing that men should try, many of them in fact, to promote the use of coal in powdered form in all places where coarser varieties have been commonly employed.

It cannot be denied that some kinds of coal can be effectively reduced to the form of powder which will float any needful distance when discharged by a blast of air or steam from a suitable nozzle. To do this, however, the coal must be very dry to begin with, and be acted upon either by very powerful rollers or by a high speed disintegrator, both of which forms of machine consume a good deal of power in their operation and require careful attention to keep them, as they must be kept, always in perfect order. If the coal is at all damp and still more if it is actually wet, as a great deal of the coal transported by water is liable to be, this process of making a powder out of it, or a mechanical gas as it has been somewhat aptly called, is rendered very difficult and, in fact, practically impossible. So also great difficulty would result from the chance of finding in a mass of coal, usually dry enough to work well, even only a few hundred pounds of damp or wet coal, which would impair the work of the pulverizer and produce great irregularity at the point of combustion.

It has been a common practice in the few cases in which pulverized coal has actually been used to put a small disintegrator at or very near each furnace, so that, in such cases, the question of distribution has been a simple matter. Plans have been made and some work has been done on a larger scale, which have included for a group of furnaces the use of a central pulverizer, and main pipes of considerable size with branches for distribution. Great trouble was found in keeping the coal powder permanently afloat in the pipes, especially at or near the bends which were used, the powder showing a tendency to settle on the bottom of the pipe whenever a change occurred in the velocity of the flow.

That this coal powder will burn vigorously cannot be doubted by those who have once seen it burn, but one bar to its successful use exists in the fact that under all ordinary conditions of working or handling a large surplus of air would almost infallibly be used above that which is needful for the complete and correct burning of the powder. This excess of air is difficult to control in the more common methods of firing coal, and it would certainly prove still more impossible to control as it must pass into the furnace under considerable pressure and volume, for the reason that the powder must be kept afloat to get it to the point of combustion at all.

This large supply of air can undoubtedly be so manipulated in the furnace as to produce a combustion which shall be quite smokeless, but under the same conditions of air supply a furnace fired in the ordinary way can be kept from smoking. At the same time it must be remembered that a smokeless furnace is almost invariably a wasteful piece of apparatus by reason of this great excess of air which is poured into it. Experience has shown most conclusively that a fire of this kind which has been referred to, when smoking at a rate which would be called decidedly smoky, is the most economical kind of a fire that could be used.

Some experimenters in this direction have seemed to think because the ash disappears, or at any rate is not left in the more common form, that it is therefore wholly consumed. This is clearly impossible, and in fact the ash residuum makes itself felt in very much the same way as in other methods of firing by its deposits, objectionable in the highest degree, upon the material which may be heated in the furnace, and in the tubes and flues of the boiler under which the powder may be used. In fact the quantity thus deposited is larger than with the ultimative methods, for the reason that all the ash-making material is floated by the air-blast beyond and away from the point of admission, nothing being left behind for accumulation as upon the fire grate.

Critical and exhaustive trials of the powdered fuel method have been made by competent men during the last 20 or 25 years. It is altogether probable that the field has been fully covered by their researches, and without any permanently useful result as measured by the rigorous standard of the ordinary conditions of everyday practice.

## ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE United Gas Improvement Company has contracted with the Richmond County Gas Light Company to erect one of its sets of standard modern Lowe apparatus at that Company's works at Stapleton, Staten Island, N.Y. The plant, of 300,000 cubic feet daily capacity, and complete with all the latest improvements, will replace the present old water gas apparatus of the Flannery form, and an important economy in operation is expected to be the result.

MENTION of this contract brings to mind the fact that work is being vigorously pushed at New Orleans, La., by the United Gas Improvement Company, under its contract for water gas apparatus with the New Orleans Gas Light Company.

ANOTHER turn in the many recently experienced in the fortunes of the Ellenville (N.Y.) Gas Company is its transfer to New York parties, who, it is said, propose to put the works in first class order. Would it be too much to hope that the gas supply of Ellenville is about to be put on a permanent basis?

THE Scranton (Pa.) *Tribune* says that the only State in which the use of natural gas for manufacturing purposes increased last year is Indiana. The total value of natural gas consumed in the country in the year was $14,346,250, against $14,800,714 in 1892. The higher prices charged for the gas in 1893 was the cause of the decrease. The greatest value of the gas consumed in any one year was $22,629,875 in 1888. Since that time there has been a gradual decline, with an aggregate of about $8,300,000 less for last year than 1888. All States show a falling off in the value of coal or wood displaced by the use of gas. The amount of this reduction in Pennsylvania was $420,000; in Ohio, $48,000; in Indiana, about $1,300. The reported number of feet of pipe laid increased during the year to 11,989,657 in Pennsylvania; to 5,720,373 feet in Indiana; and

1,404,098 in Ohio. The largest value in any one year of the gas produced was $19,282,375 in 1888, in Pennsylvania, since which it has fallen to $6,488,000. Ohio showed the largest falling off for the year 1893; in 1892 the value was $2,136,000; in 1893 it was $1,510,000. The most important gas field in any State is shown to be in Indiana, the estimated productive gas territory in which is about 2,500 square miles. While the supply is falling below the demand in other gas fields, it is declared to be well sustained in Indiana, and supplies are being obtained from the State by factories located in other gas territories. The value of the product consumed in the State in 1893 was $5,718,000, against $4,716,000 in 1892.

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FROM the annual report of President Westinghouse, of the Philadelphia Natural Gas Company, for the year ended March 31, 1894, we learn that the Company believes the time has come when it is no longer safe to count upon a satisfactory supply of natural gas, and in that light it has been determined to go into the manufacture of fuel gas on a large scale, more particularly in the district of Allegheny county, which contains the cities of Pittsburgh and Allegheny City, besides many populous towns and villages eligibly situated for the supply of gas. In fact, the report of the Company's intentions seems to indicate trouble for the artificial gas companies in Pittsburgh, in the shape of competition from the Philadelphia Company, as witness the following paragraph from the report referred to: "Your Company has a most extensive system of mains, having connections with about 30,000 houses in Pittsburgh, Allegheny and surrounding localities. This system has cost and is worth a very large sum of money, but its value depends upon having an adequate supply of gas. Your officers and directors have continued to give careful attention to the question of manufacturing gas, which, combined with the natural gas obtainable from the various fields, shall produce a sufficient revenue to give good returns to the stockholders of the Company. It is believed, from the investigations and computations made, that the time has about arrived when the Company can profitably manufacture gas from coal, and your directors have therefore deemed it wise to purchase a site of about 181 acres, most favorably located, on which the Company will proceed with the erection of a modern gas plant to meet the requirements of the Company. For the purpose of acquiring the site above referred to, and for the beginning of the erection of a plant, the Company has now available over half a million dollars in its treasury."

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THE Tonawanda (N. Y.) Gas Light Company offers to supply gas for street lighting at the rate of $20 per lamp per year, and will supply gas to the public buildings, including the fire engine houses, at the rate of $1 per 1,000 cubic feet.

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THE action taken by the shareholders of the Detroit (Mich.) Gas Company, who assembled in this city for the first time in annual meeting since the organization of the Company a year ago, was as follows: Directors chosen, C. P. Huntington, Thomas H. Hubbard, John Byrne, D. M. Ferry, M.W. O'Brien, W. C. McMillan, Eugene T. Lynch, John C. Donnelly, William H. Wells, Jerome Croul, F. A. Driggs, Frank S. Smith and F. R. Pemberton. The Directors subsequently perfected the following executive management: President, Eugene T. Lynch; Secretary and Treasurer, M. W. O'Brien; Manager, F. P. Byrne.

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"INQUIRER" propounds the following query, any replies to which will be published in the JOURNAL:

To the Editor of the AMERICAN GAS LIGHT JOURNAL: The writer would feel greatly obliged if some of the readers of your valuable JOURNAL would give their opinion on laying cast iron gas mains alongside of water mains; also their experiences regarding pipes so laid.

---

MR. L. Z. FARWELL, proprietor of the Freeport (Ills.) Gas Light and Coke Company, has disposed of the Company's electric annex to an Eastern syndicate, who propose to operate it in connection with the local street car line, recently purchased by the same capitalists, and which is to be equipped for electric operation.

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THE Medford (Mass.) Board of Aldermen recently adopted an order declaring that it is expedient that Medford should establish a plant for the manufacture of gas or electricity, on public account.

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THE Berlin Iron Bridge Company, of East Berlin, Conn., has paid its regular quarterly dividend of 1½ per cent. Considering the hard times in all branches of business, especially among the manufacturers of structural iron, we think this shows pretty good management—not to put it any stronger, and is in refreshing contrast to the reports received from so many quarters of closed factories and passed dividends.

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THE Thomas-Brice syndicate, which controls the Fort Wayne (Ind.) Natural Gas Company, has purchased the property of the Fort Wayne Gas Company, paying therefor about 80 per cent. of the par value of the capital stock.

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A SLIGHT fire occurred some time ago in the organ loft of St. Mary's (Roman Catholic) Church, Stockton, Cal., which was occasioned by the crossing of the electric conductors leading to and from the motor that pumps the organ.

---

A CORRESPONDENT at Oakland, Cal., writing under date of May 1st, incloses the following from the San Francisco *Examiner*, of the same date: "The announcement is made that Oakland is to have another Gas Company, to be headed by Mr. R. W. Gorrill, a well known contractor and bridge builder. Mr. Gorrill has been the President and an active member of the Pacific Bridge Company, holding in his own name a controlling interest in the stock of that Company for many years. He is still the President of the Company, but some time ago sold out his controlling interest and retired from contracting. A short time ago he made a mysterious trip to New York, upon some business that was not openly stated, and returned to Oakland only a few days ago. It is now announced that he went East for the purpose of making the preliminary arrangements for his Gas Company, investigating the latest gas making appliances, and incidentally talking a little finance to some Eastern capitalists. The new Company is said to be practically ready for incorporation, though who compose it is not so clearly known. 'I have my Company organized, though not incorporated,' said Mr. Gorrill, when recently appealed to on the subject. 'More than this I do not care to say, for the matter may never go beyond its present stage. I am still considering the advisability of going into the business, but if I go ahead it will be within the next 30 days. It is true that my visit to New York was to an extent in the interests of the proposed Company. While I was there I investigated the latest appliances for making gas, and had plans drawn and estimates made for a plant such as I should build. These reports have not yet been made in detail, and until they are, the exact fate of the Company will not be known. In the meantime, I have secured options upon three different pieces of land whereon I could construct my plant. The Company is all ready for incorporation, and the moment that it is decided to go ahead we will be ready to plunge right into the business. I have some Eastern capital interested in the Company, and some local capital. It will be a spot cash proposition and no stock or bonds will be offered for sale. I have been looking into new methods of making gas, and while I shall not go in for making any experiments, I will have the latest and most economical way of manufacturing gas without any intention of selling 100 cubic feet of greased wind for 1,000 cubic feet of good illuminating gas.' Mr. Gorrill has plenty of money of his own, and could easily raise cash enough for such an enterprise, and if the new Company goes through there will be some lively competition in the gas business in Oakland. The new Company, as planned, proposes to cover not only Oakland, but the adjoining suburbs of Alameda and Berkeley."

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AT the annual meeting of the Roanoke (Va.) Gas and Water Company 4,600 shares, out of a possible 6,000, were represented, and the following Board of Directors was chosen: Clarence H. Clarke, F. J. Kimball, Joseph I. Doran, J. H. Dingee, Joseph J. Martin and C. Howard Clarke, Jr., of Philadelphia, and P. L. Terry, H. S. Trout, J. H. Sands, J. W. Coxe and G. W. Ramsey, of Roanoke.

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THE proprietors of the Le Roy (N.Y.) Company, who are well pleased with the new plant recently completed, contemplate reducing the selling rate, from $2 to $1.60 per 1,000 cubic feet.

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THE Le Mars (Iowa) *Sentinel* says that Mr. T. C. Leggett, of Sioux City, was in Le Mars some days ago for the purpose of investigating the operation and gaining general business information concerning the Le Mars Gas Light Company's plant, representing the interest of the bondholders. It is a well known fact that for some time the Le Mars works have not been fully up to the standard. More capital is needed. The plant has been run on the hand-to-mouth plan too long. Improvements should have been made, which would have given the Manager, Mr. Kellogg, a chance to earn something for the proprietors. As the plant has not been paying interest on the money invested, one of two things must soon be done—either close the works or put them in such shape that the sales can be increased. The plan proposed by Manager Kellogg

and sanctioned by Mr. Leggett is to change the system over to water gas and extend the mains, which it is claimed can be done for less than $10,000.

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At the annual meeting of the shareholders of the Easton (Pa.) Gas Company the Directors elected to serve for three years were: Eli M. Fox, Edwin F. Lawall and George M. Odenwelder. The Directors organized by electing Samuel Boileau, President; Edwin F. Lawall, Treasurer; William H. Ward, Superintendent.

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The Cleveland Gas Fixture Company, of Cleveland, Ohio, has filed an assignment to Henry N. Hill. The assets are returned at $100,000, against liabilities of $47,000. The assets, however, are largely made up of unfinished goods, and there is a woeful lack of good bills receivable in the schedule.

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The Berlin Iron Bridge Company, of East Berlin, Conn., is putting up an extension to the carbonizing house of the Brookline (Mass.) Gas Company.

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Some time ago we noted that the proprietors of the Consumers Gas Company, of Reading, Pa., had ordered a reduction in the selling rate, and now we are in receipt of a copy of the official announcement, which is here reproduced: "On and after May 1st the price of gas for lighting will be reduced, from $2.10, with 5 per cent. off for cash in 10 days, to $2, with 20 per cent. off in 10 days, making the price $1.60, instead of $2. It is expected that this large reduction will greatly increase the consumption of gas, as it will enable many to avail themselves of this great household convenience who heretofore considered it too expensive. At this price it does not pay anyone to put up with the inconvenience and danger of inferior methods of lighting. In anticipation of largely increased consumption, we have made preparations to promptly meet the demand for new meters, and would advise everyone desiring to take advantage of the reduced rate to send in their orders at once. If you drop us a postal card, or call, one of our agents will call upon you promptly, ready to give any further explanation you may desire, and to make all arrangements for satisfactorily lighting your house or store."

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Some time ago we reported the rather eccentric action taken by City Auditor Young, of Sacramento, Cal., who refused to draw a warrant in favor of the Capital Gas Company, of that city, in payment for gas consumed on public account. He based his refusal on the ground that as Mayor Steinmann, who is also President of the Gas Company, was an interested party, he could not legally certify to the correctness of the account rendered, whereupon the Company appealed to the courts, with the result that the Auditor has been directed to draw the necessary warrants.

---

The United States Government has determined to abandon the site selected for the proposed new mint building in Philadelphia, which site was located on Broad and Cherry streets, and will re-locate it on the square bounded by Buttonwood and Spring Garden, and 16th and 17th streets. This will save the meter manufacturing shops of Messrs. Helme & McIlhenny, which the Government proposed to acquire at a figure very much below their real value.

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The Helena (Mont.) Electric Light Company has gone into the hands of a receiver, and it is suggested that it will eventually come under the control of the Helena Gas Light Company.

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On the 7th inst. the Natick (Mass.) Gas Light Company opened an exhibition of gas stoves for cooking and heating, together with a varied assortment of burners, lamps, etc., the exhibits being tastefully displayed in a store in Odd Fellows' Block. The exhibition lasted six days, the opening hours running from 8 A.M. to 9 P.M. During the morning, from 9 A.M. to 11 A.M., and in the afternoon, from 2:30 P.M. to 5 P.M., cooking by gas was practically illustrated, and the whole affair was under the supervision of Mr. J. R. Todd, who it will be remembered acted as Superintendent of the Natick Company for some years. The Company will rent, or sell for cash, or sell under the installment plan, any needed apparatus for cooking or heating, and further agrees to put in the necessary services and connections free of cost. The rate for gas used for cooking, between April 1st and October 1st, has been fixed at $1.50 per 1,000 cubic feet.

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The Directors chosen at the annual meeting of the United Gas Improvement Company were: George Philler, William G. Warden, P. A. B. Widener, William L. Elkins, William W. Gibbs, Clement A. Griscom and Thomas Dolan.

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The proprietors of the Phœnix Gas Light and Fuel Company, of Phœnixville, Pa., have announced their determination to reduce the selling rate to $1.25 per 1,000 cubic feet.

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The Directors chosen at the annual meeting of the Cooperstown (N.Y.) Gas and Electric Light Company were Messrs. Chas. B. Staats, O. R. Butler, B. F. Murdock, James Bunyan and Lee B. Cruttenden.

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A controlling interest in the Citizens Gas and Electric Company, of White Plains, N.Y., has been purchased by Brooklyn capitalists, prominent among whom is Mr. Alexander A. Forman, who has been elected President of the Company. The other officers are: Treasurer, Jas. G. Forman; Secretary and Superintendent, R. E. Slade.

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Mr. V. L. Elbert has secured an interest in the Menominee Gas Light Company, of Menominee, Mich., and will enlarge the same.

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On the 1st inst., the gas rates at Lockport, N.Y., were reduced to $1.70 and $1.50 per 1,000 cubic feet, for lighting and fuel uses, respectively.

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The property and franchises of the Phœnix (Arizona) Electric Light and Power Company will be sold at foreclosure sale on the morning of June 22d. The concern was virtually bankrupt from the start.

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The tank steamer Bawnmore arrived in San Francisco recently with the first cargo of Peruvian petroleum, under the system of transportation initiated by J. W. Grace & Co. The cargo amounted to about 800,000 gallons, a large part of which was taken by the San Francisco Gas Company.

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The temper of the Philadelphia authorities is decidedly against any proposition to sell or lease the gas works to private capitalists.

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*Revue Industrielle* avers that experiments undertaken at Reims have demonstrated that gasoline gas has advantages over coal gas when applied to the singeing of woolen fabrics. In using coal gas the blue part of the flame is nearest the warp of the goods, and the fabric touched by the yellow part only is exposed to a very moderate heat, the finer qualities of goods needing more frequent contacts with the flame. With gasoline gas the blue part of the flame is forced up or dispelled along the flame itself, and the maximum of heat is applied to the surface of the goods, the heat being utilized so that the number of contacts is reduced to a half or a third, according to the quality of goods under treatment.

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At the annual meeting of the Southside Gas Company, of Pittsburgh, Pa., the following officers were elected: Directors, George Trautman, Martin Maloney, George W. Elkins, William A. Heyl, Joseph G. Walter, William H. Alldred, Remsen V. Messler, Robert B. Brown and Samuel T. Bodine; President, George Trautman; Secretary, William H. Alldred.

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The new terminal facilities for the New York, New Haven and Hartford Railroad Company, at Providence, R. I., will necessitate two large bridges, which will be furnished by the Berlin Iron Bridge Company, of East Berlin, Conn. The bridges will carry 16 tracks over Gaspee street, Promenade street and Woonasquatucket river. The bridges will be plate girders, resting on abutments at the street line and on columns at the curb line. No floor beams or stringers will be used, in place of which a metal floor will support ballast, in which the ties and rails will be bedded. The work will require about 4,500 tons of open hearth steel material, and the Berlin Company is to be allowed six months in which to complete the job.

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The Harrison (N. J.) authorities have authorized the making of a contract with the Excelsior Electric Light Company for the public arc lighting. The rate agreed on is 37 cents per arc per night, each lamp to be of 2,000 candle power, an all night and every night schedule to be followed.

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The output of the Ionia (Mich.) Gas Light and Coke Company (the works of which were completed in 1882) for the past year amounted to seven million cubic feet.

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The Hartford (Conn.) City Gas Light Company has abrogated the agreement entered into between it and the Hartford Electric Light Company, which agreement was entered into on August 31, 1886. Meanwhile the relations between the Companies are to remain amicable.

THE AMERICAN
GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

EDITOR—Jos. R. Thomas, C.E.
ASST. EDITOR—T. J. Cunningham.
MANAGER—C. E. Sanderson.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

This is a recognized official organ of
LIGHT, HEAT, STEAM, WATER SUPPLY,
VENTILATION, SANITARY IMPROVEMENT,
AND GENERAL SCIENCE

TERMS:

SUBSCRIPTION—Three Dollars per annum, in advance. Single copies, 10 cents.

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NEW YORK.—AMERICAN NEWS CO., 39 and 41 Chambers Street
*Germany.*—B. WESTERMANN & CO., of New York.

MONDAY, MAY 14, 1894.

## The Market for Gas Securities.

The market for Consolidated was weak since time of last writing, and the opening to day (Friday) was made at 135½ to 136½. The rate war in Brooklyn and the windy advertising methods of the East River Gas Company have exerted a depressing effect, in that timid investors have been offering their holdings. Of the two disturbing factors, by far the more to be feared is the rate war. Brooklyn shares are, and quite naturally, dull, and there is no doubt they will all be lower. Every stock on the Brooklyn list is a sale. Baltimore Consolidated shows no change of moment, although it is a trifle easier this week than last, and Chicago gas is strong, at 66¼ to 66½. Bay State is slow and uneven, with a decided downward tendency, and Laclede common is also in the dumps. The possible advent of the Philadelphia Gas Company as a manufacturer and supplier of artificial gas in the Pittsburgh district has disturbed gas share values in that section, but much time will elapse before this scheme can be perfected.

## Gas Stocks.

**Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,**
16 WALL ST., NEW YORK CITY.
MAY 14.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

| | Capital. | Par. | Bid | Asked |
|---|---|---|---|---|
| Consolidated | $35,430,000 | 100 | 135½ | 136½ |
| Central | 500,000 | 50 | 100 | — |
| " Scrip | 220,000 | — | 100 | — |
| Equitable | 4,000,000 | 100 | 186 | 190 |
| " Bonds | 1,000,000 | — | 106 | 108 |
| Metropolitan, Bonds | 658,000 | — | 108 | 112 |
| Mutual | 3,500,000 | 100 | 150 | — |
| " Bonds | 1,500,000 | — | 100 | 102 |
| Municipal, Bonds | 750,000 | | — | — |
| Northern | | 50 | 80 | 95 |
| " Bonds | 150,000 | — | — | 100 |
| Richmond Co., S. I. | 348,650 | 50 | 50 | — |
| " Bonds | 100,000 | — | — | — |
| Standard Gas Co— | | | | |
| Common Stock | 5,000,000 | 100 | 24 | 27 |
| Preferred | 5,000,000 | 100 | 77 | 81 |
| Yonkers | | 50 | 112 | — |
| Gas Co's of Brooklyn. | | | | |
| Brooklyn | 2,000,000 | 25 | — | 105 |
| Citizens | 1,200,000 | 20 | 50 | — |
| " S. F. Bonds | 320,000 | 1000 | — | 101 |
| Equity Gas Light Co | 2,000,000 | 100 | — | — |
| Bonds | 1,000,000 | — | — | — |
| Fulton Municipal | 3,000,000 | 100 | 128 | — |
| " Bonds | 300,000 | | 103 | — |
| Peoples | 1,000,000 | 10 | — | 68 |
| " Bonds (7's) | 368,000 | — | 100 | — |
| " " (6's) | 94,000 | — | 98 | 100 |
| Metropolitan | 870,000 | 100 | 127 | — |
| " Bonds (5's) | 70,000 | — | 100 | — |
| Nassau | 1,000,000 | 25 | — | 160 |
| " Ctfs | 700,000 | 1000 | 99 | 100 |
| Williamsburgh | 1,000,000 | 50 | 130 | — |
| " Bonds | 1,000,000 | — | 107 | 110 |
| Out of Town Gas Companies. | | | | |
| Bay State Gas Co.— | | | | |
| Stock | 5,000,000 | 50 | 17 | 17½ |
| Income Bonds | 2,000,000 | 1000 | 60 | — |
| Boston United Gas Co.— | | | | |
| 1st Series S.F. Trust | 7,000,000 | 1000 | 78 | — |
| 2d " " " | 3,000,000 | 1000 | 57 | 58 |
| Buffalo Mutual, N. Y. | 750,000 | 100 | 121 | 125 |
| " Bonds | 200,000 | 1000 | 95 | 100 |
| Citizens, Newark | 1,000,000 | 50 | 155 | 160 |
| Chicago Gas Company. | 25,000,000 | 100 | 66¼ | 66½ |
| Chicago Gas Light. & Coke Co.— | | | | |
| G't'd Gold Bonds | 7,650,000 | 1000 | 81⅛ | 81½ |
| Consumers Gas Light Co., Jersey City | 2,000,000 | 100 | 43 | 47 |
| Bonds | 600,000 | 1000 | 84 | 90 |
| Cincinnati G. & C. Co. | 7,000,000 | 100 | 192 | — |
| Consumers Toronto | 1,600,000 | 50 | 184½ | 187 |
| Central, S. F., Cal | | | — | 100 |
| Capital, Sacramento, Cal | | | — | 55 |
| Consolidated, Balt | 11,000,000 | 100 | 65¼ | 65½ |
| " Bonds | 6,400,000 | | 107 | 107½ |
| Citizens Gas Lt. Co., Rochester, N. Y. | 500,000 | — | 85 | 101 |
| Bonds | 250,000 | | — | — |
| Detroit Gas Co.— | | | | |
| Con. Bonds | | | 65 | 70 |
| East River Gas Co., Long Island City | 1,000,000 | 100 | — | — |
| Bonds | 500,000 | 100 | 89¼ | — |
| Equitable Gas & Fuel Co., Chicago, Bonds | 2,000,000 | 1000 | — | 101 |
| Hartford, Conn | 750,000 | 25 | 120 | 128 |
| Jersey City | 750,000 | 20 | 190 | 200 |
| Louisville, Ky | 2,570,000 | 50 | 125 | 130 |
| Laclede Gas Light Co. St. Louis, Mo.— | | | | |
| Common Stock | 7,500,000 | 100 | 17 | 18 |
| Preferred " | 2,500,000 | 100 | 69 | 72 |
| Bonds | 9,034,400 | 1000 | 88 | — |
| Little Falls N. Y. | 50,000 | 100 | — | 100 |
| " Bonds | 25,000 | — | 100 | 103 |
| Montreal, Canada | 2,000,000 | 100 | 200 | 208 |
| New Haven, Conn | | 25 | 200 | — |
| Oakland, Cal | | | 42⅜ | 43 |
| People's Gas and Coke Co., Chicago— | | | | |
| 1st Mortgage | 2,100,000 | 1000 | — | 108 |
| 2d " | 2,500,000 | 1000 | 104 | 105 |
| Peoples, Jersey City | | | 160 | 170 |
| " " Bonds | | | — | — |
| Paterson, N. J | | 25 | 99 | 102 |
| Rochester, N. Y | | 50 | 80 | 85 |
| Preferred | | | 90 | 95 |
| Bonds | | | 90 | 95 |
| Syracuse, N. Y | 500,000 | 25 | — | — |
| San Francisco Gas Co. San Francisco, Cal | 10,000,000 | 100 | 65½ | 66 |
| Washington, D. C | 2,000,000 | 20 | 240 | — |
| Wilmington, Del | 500,000 | 50 | 180 | 182 |

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## RECEIVER'S SALE.

By virtue of an order and decree granted by the Circuit Court of the United States, for the Northern District of Georgia, in the case of International Trust Company vs. The Cartersville Improvement Gas and Water Company et al., now pending in said Court, the undersigned, appointed receiver in said case, of all and singular the property of The Cartersville Improvement Gas and Water Company, defendant, will expose to sale at public out-cry to the highest bidder, before the Superior Court House door, in Atlanta, Ga., on the first Tuesday in July next, within legal sale hours, the following described property, to wit: The entire Gas Works, known as The Cartersville Improvement Gas and Water Company's Gas Plant, located and being in the city of Cartersville, Bartow County, Ga., consisting of the following lands, fixtures and appurtenances, to wit: A certain tract of land situated in Cartersville, Bartow County, Ga., containing one acre more or less, bounded on the north by Cook street, west by Erwin street, south and east by lands of Amos T. Akerman, deceased, being the tract of land conveyed by Martin Collins to Cartersville Improvement Gas and Water Company by deed recorded in book "A.A." of deeds, page 151, Clerk's office, Bartow Superior Court: also a certain other parcel of land, in the city of Cartersville, Bartow County, Ga., containing two acres more or less, the same being a square tract of land, each side 282 feet long, situate on Cook street, in the Third Ward of said city, boundary commencing at the intersection of the center line of Cook street with the center line of Bartow street, running from said point thence south along the east line bounding the lands of A. M. Willingham 282 feet, thence running east parallel with Cook street 282 feet, thence north parallel with the east line of said Willingham lot aforesaid to the center line of Cook street, thence along said Cook street to the point of beginning, the same being the parcel of land conveyed by William J. Neel to the Cartersville Improvement Gas and Water Company, by deed recorded in book "A A.," pages 327 and 328, record of deeds, Clerk's office, Bartow Superior Court.

Also all buildings, machinery, improvements and equipments now located on said last described parcel of land, and used for the purpose of manufacturing, conserving, distributing and selling gas, including the engines, piping, boilers, water tanks, gasholders and oil tanks; and also all gas pipes, lamp posts, street mains, service pipes and globes, located in the city of Cartersville, Ga., and connected with said Gas Plant for the distribution of gas through said city, together with all tools, gas fixtures, fittings and supplies, rights, privileges, franchises and appurtenances belonging thereto. All of said property now being in the possession of the undersigned as Receiver aforesaid, and all to be sold by virtue of the order and decree aforesaid, as the property of the Cartersville Improvement Gas and Water Company.

The terms of sale will be as follows: One thousand dollars to be paid by the purchaser to the Receiver in cash, when the property is knocked off at said sale; one-third of the whole purchase price, including said one thousand dollars, to be paid on the confirmation of said sale by said Court; one-third to be paid in three months and one-third in six months from date of the confirmation of said sale by said Court, the said deferred payments to bear interest at the rate of six per cent. per annum from the date of confirmation of the sale as aforesaid, notes therefor to be executed and delivered by the purchaser to said Receiver, with security to be approved by said Receiver, the purchaser to have the right to pay the deferred installments at any time before the maturity thereof. The possession of the property to be delivered to the purchaser on confirmation of the sale by said Court. That upon the confirmation of the sale by the Court, and the payment of the first installment of one-third of the purchase price and delivery of the purchaser's notes to the Receiver, for the remaining installments the Receiver will execute and deliver to the purchaser, bond to make titles, on payment of the balance of the purchase money, the purchaser to be required to keep the property in reasonable repair until the purchase price is fully paid.

By virtue of said order and decree of said Court the Receiver will also receive private bids from anyone, at any time prior to the date of the public sale, same to be reported to said Court for acceptance or rejection.

For further information, address William B. Miller, Receiver of Cartersville Improvement Gas and Water Company, Cartersville, Ga.

This 24th day of April, 1894.

WILLIAM B. MILLER,
Receiver of the Cartersville Improvement Gas and Water Company.
986-4


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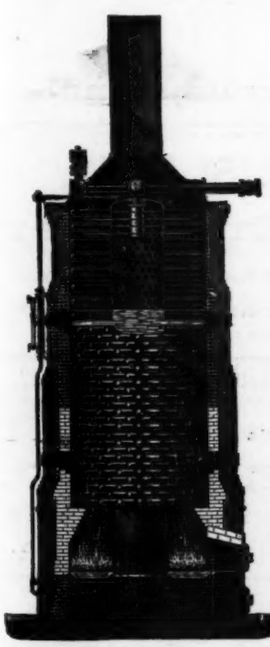

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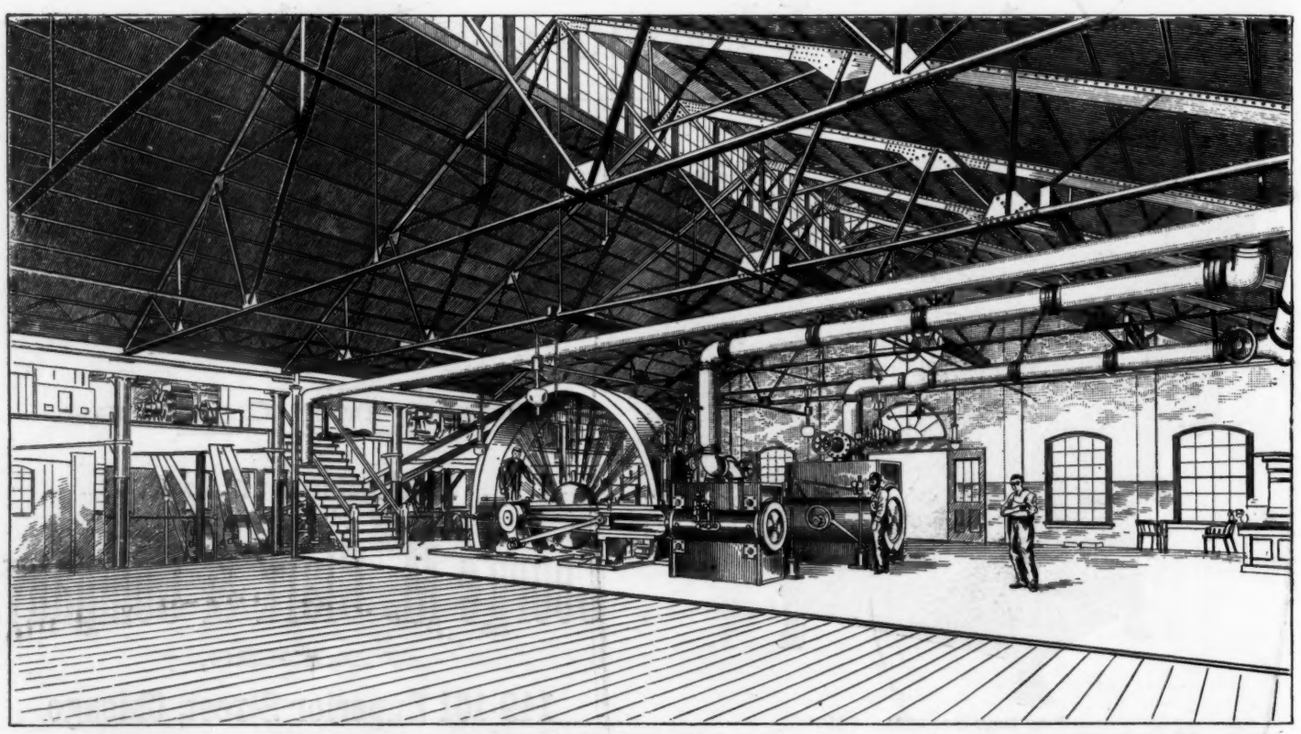

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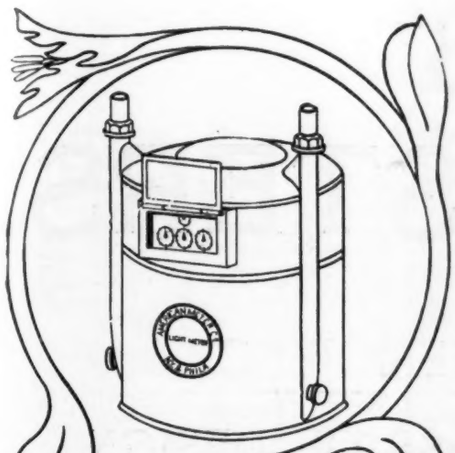

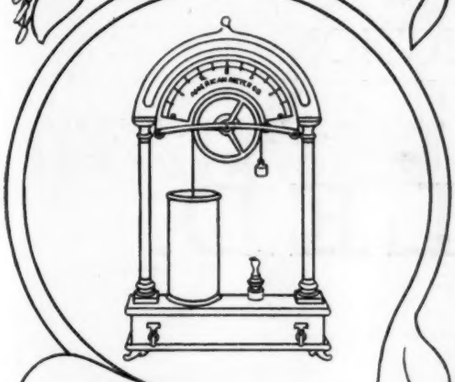

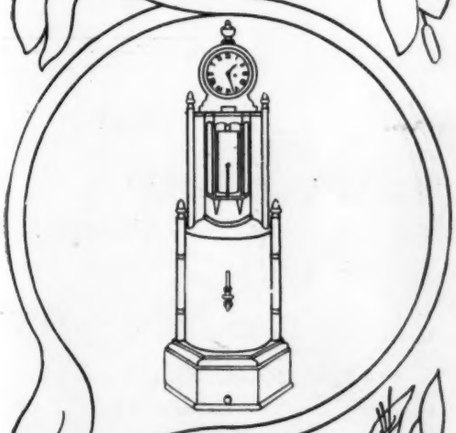

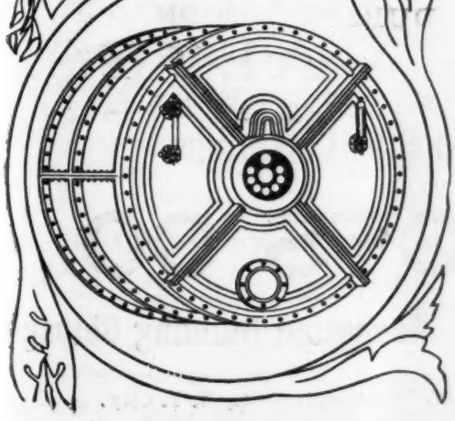

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SAN FRANCISCO.

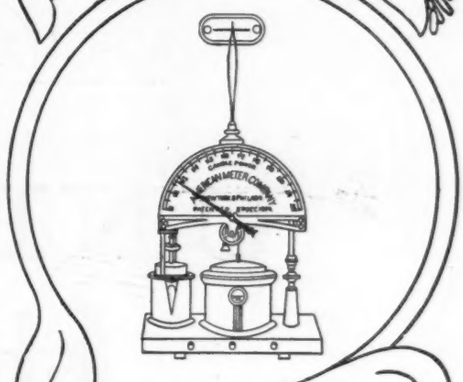
## PUBLIC LIGHTING TABLE.

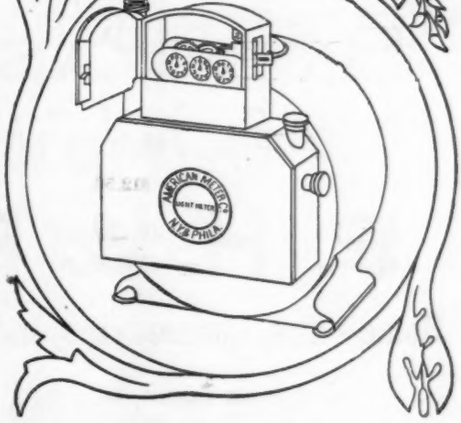
### MAY, 1894.

| Day of Week. | Date. | Table No. 1. Following the Moon. Light. | Table No. 1. Following the Moon. Extinguish. | Table No. 2. New York City. All Night Lighting. Light. | Table No. 2. New York City. All Night Lighting. Extinguish. |
|---|---|---|---|---|---|
| | | | | P.M. | A.M. |
| Tue. | 1 | 7.20 PM | 4.00 AM | 6.45 | 4.00 |
| Wed. | 2 | 7.20 | 4.00 | 6.45 | 4.00 |
| Thu. | 3 | 7.30 | 4.00 | 6.45 | 4.00 |
| Fri. | 4 | 7.30 | 4.00 | 6.45 | 4.00 |
| Sat. | 5 | 7.30 NM | 4.00 | 6.45 | 4.00 |
| Sun. | 6 | 7.30 | 3.50 | 6.45 | 4.00 |
| Mon. | 7 | 7.30 | 3.50 | 6.55 | 3.40 |
| Tue. | 8 | 7.30 | 3.50 | 6.55 | 3.40 |
| Wed. | 9 | 7.30 | 3.50 | 6.55 | 3.40 |
| Thu. | 10 | 11.10 | 3.50 | 6.55 | 3.40 |
| Fri. | 11 | 11.50 | 3.50 | 6.55 | 3.40 |
| Sat. | 12 | 12.20 AM FQ | 3.50 | 6.55 | 3.40 |
| Sun. | 13 | 12.50 | 3.50 | 6.55 | 3.40 |
| Mon. | 14 | 1.10 | 3.50 | 7.00 | 3.30 |
| Tue. | 15 | 1.40 | 3.50 | 7.00 | 3.30 |
| Wed. | 16 | 2.00 | 3.40 | 7.00 | 3.30 |
| Thu. | 17 | No L. | No L. | 7.00 | 3.30 |
| Fri. | 18 | No L. | No L. | 7.00 | 3.30 |
| Sat. | 19 | No L. FM | No L. | 7.00 | 3.30 |
| Sun. | 20 | 7.40 PM | 9.40 PM | 7.00 | 3.30 |
| Mon. | 21 | 7.40 | 10.40 | 7.10 | 3.15 |
| Tue. | 22 | 7.40 | 11.30 | 7.10 | 3.15 |
| Wed. | 23 | 7.40 | 12.10 AM | 7.10 | 3.15 |
| Thu. | 24 | 7.50 | 12.50 | 7.10 | 3.15 |
| Fri. | 25 | 7.50 | 1.20 | 7.10 | 3.15 |
| Sat. | 26 | 7.50 | 1.40 | 7.10 | 3.15 |
| Sun. | 27 | 7.50 LQ | 2.00 | 7.10 | 3.15 |
| Mon. | 28 | 7.50 | 2.20 | 7.15 | 3.15 |
| Tue. | 29 | 7.50 | 2.50 | 7.15 | 3.15 |
| Wed. | 30 | 7.50 | 3.10 | 7.15 | 3.15 |
| Thu. | 31 | 7.50 | 3.30 | 7.15 | 3.15 |

### TOTAL HOURS LIGHTING DURING 1894.

| By Table No. 1. | Hrs. Min. | By Table No. 2. | Hrs. Min. |
|---|---|---|---|
| January | 244.10 | January | 423.20 |
| February | 195.30 | February | 355.25 |
| March | 206.20 | March | 355.35 |
| April | 169.40 | April | 298.50 |
| May | 162.10 | May | 264.50 |
| June | 135.40 | June | 234.25 |
| July | 146.30 | July | 243.45 |
| August | 162.20 | August | 280.25 |
| September | 174.10 | September | 321.15 |
| October | 211.20 | October | 374.30 |
| November | 221.00 | November | 401.40 |
| December | 245.30 | December | 433.45 |
| Total | 2274.20 | Total | 3987.45 |





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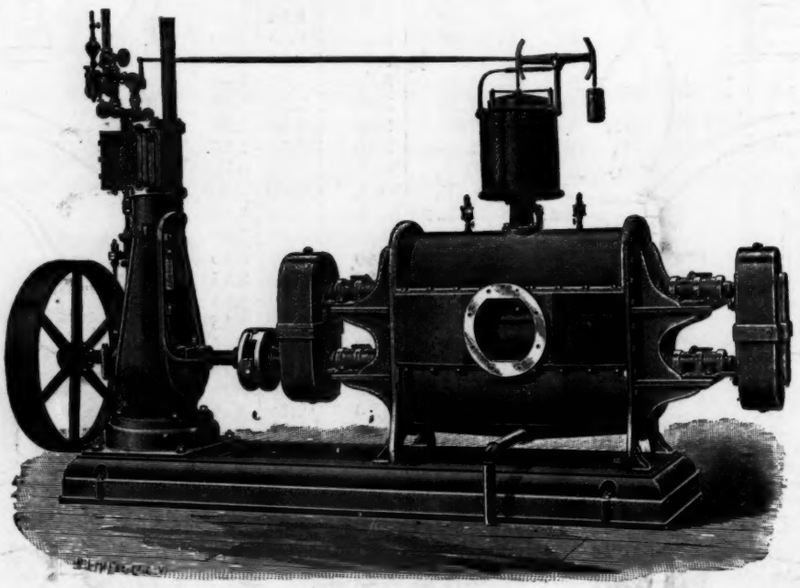

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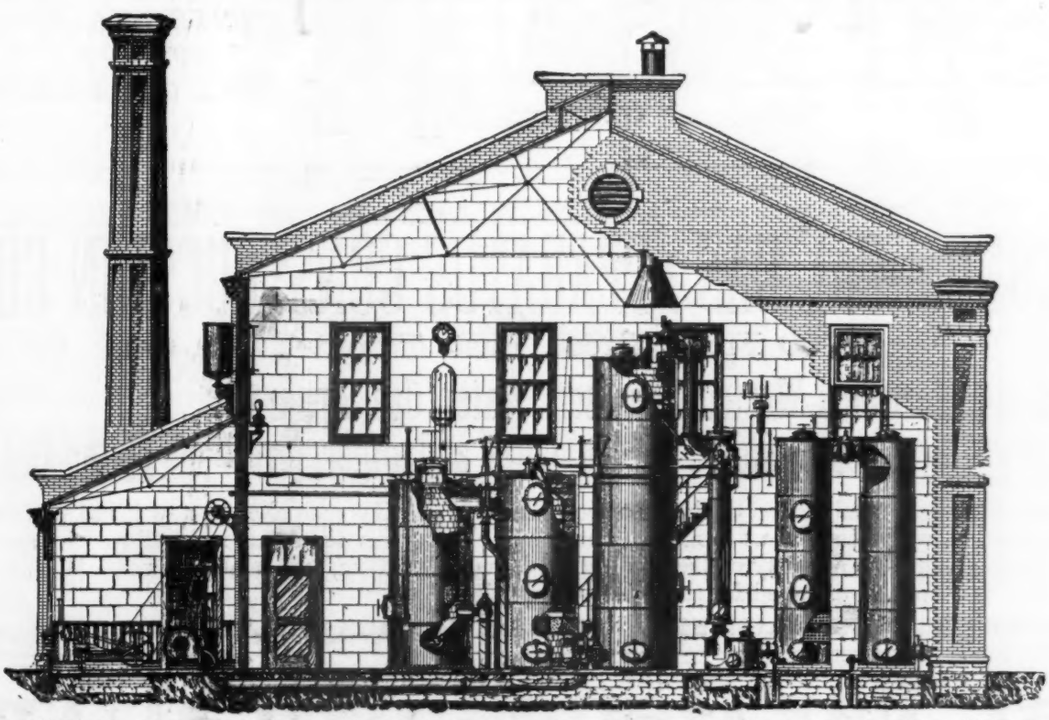

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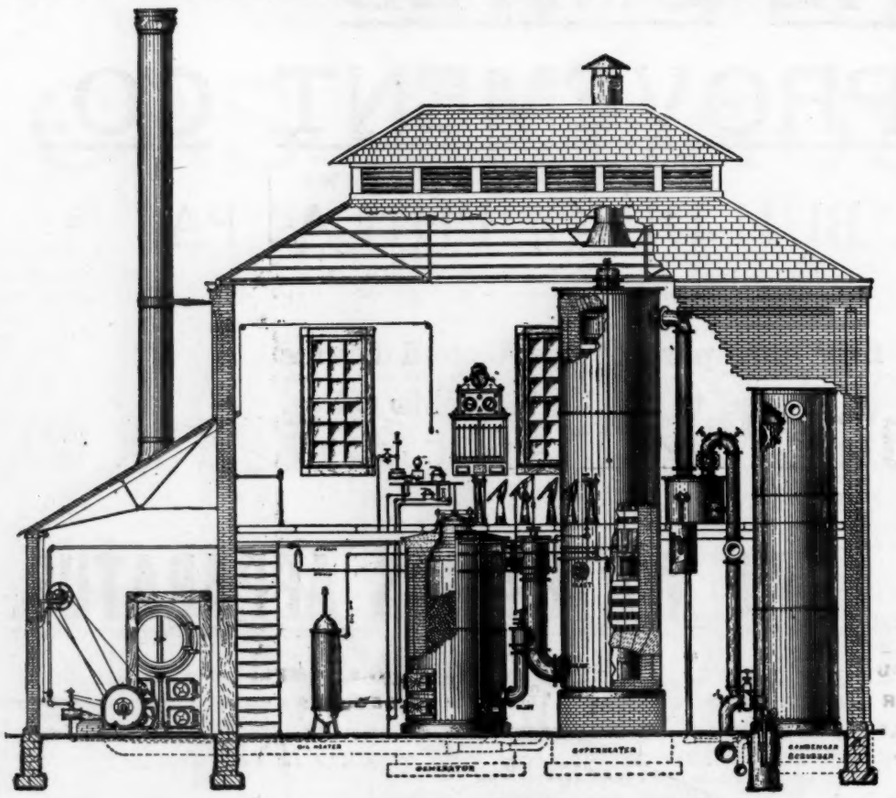

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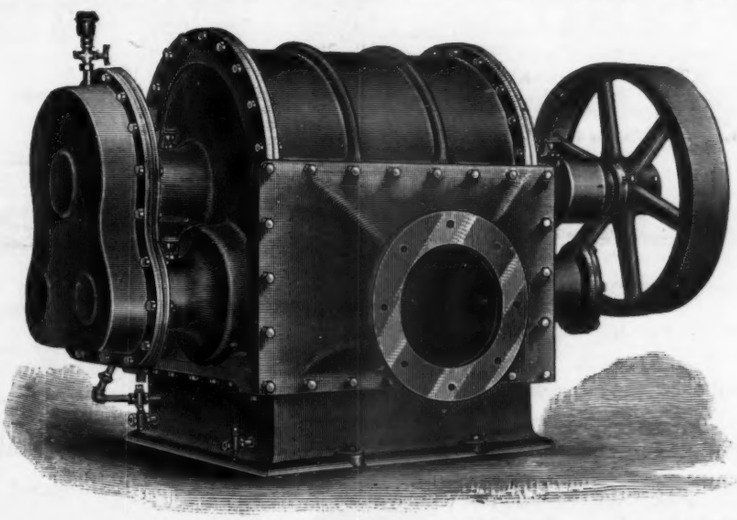

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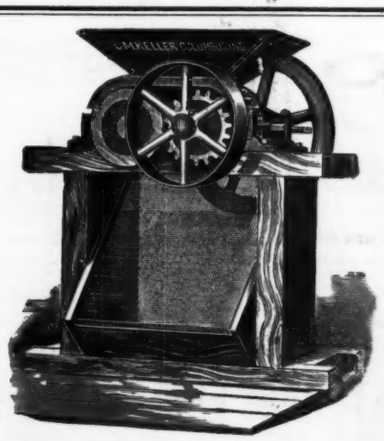

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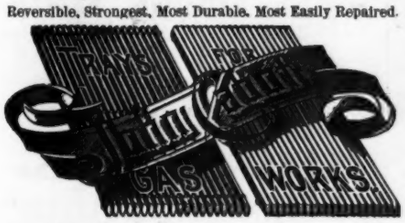


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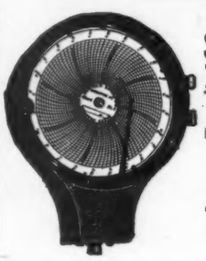

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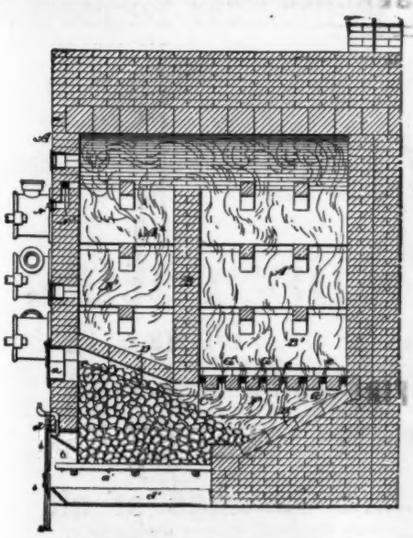

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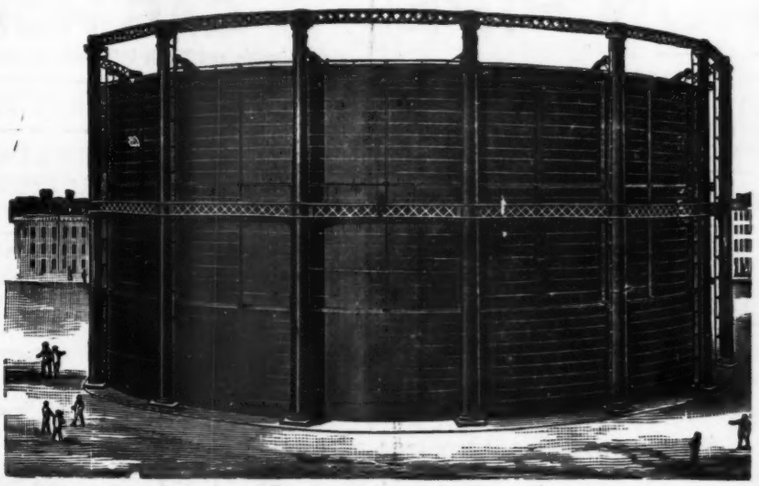

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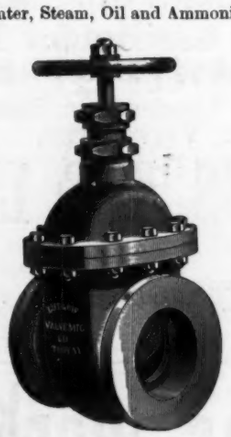

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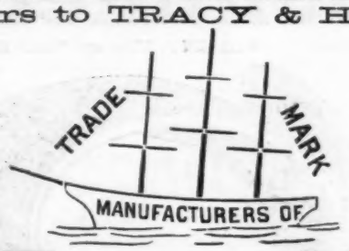


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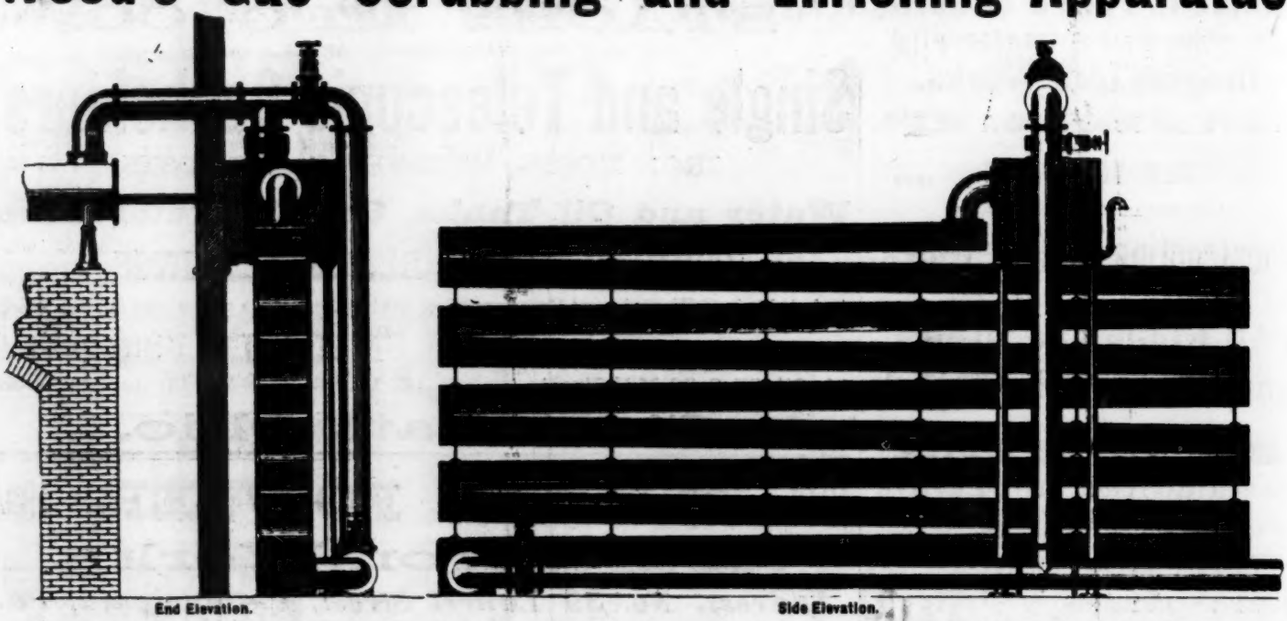


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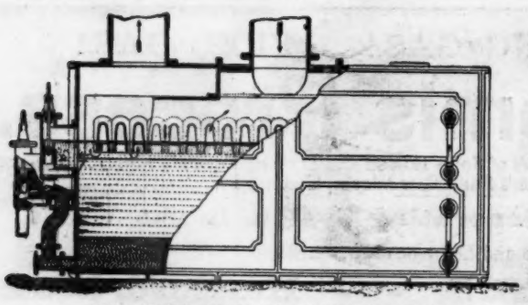

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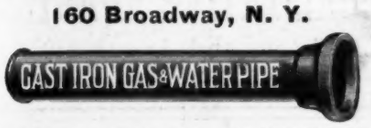


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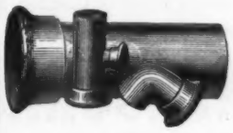

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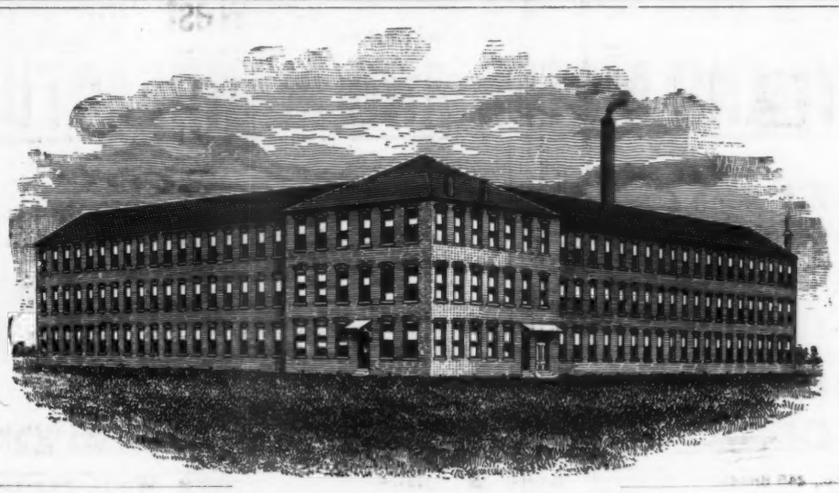

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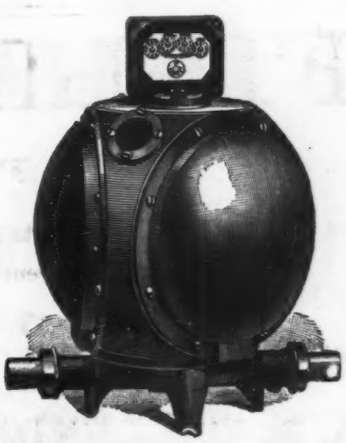

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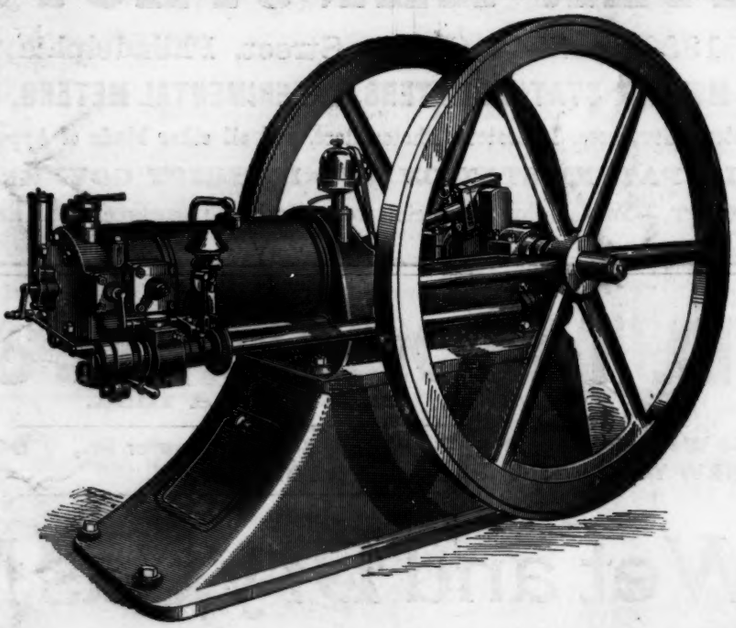

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